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INFRACLAVICULAR FOCI OF INFILTRATION AS EVIDENCE OF INCIPIENT TUBERCULOSIS OF THE LUNGS IN YOUNG ADULTS[1]

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DURING the last eight years I have encountered what I believe to be a characteristic type of pulmonary lesion in the early stage of tuberculosis of the lungs, particularly in young adults. I first described this type of lesion in the second edition of my "Clinical Roentgen Diagnosis of Internal Diseases," 1922, and later, in 1924, in Brauer's "Contributions to the Clinical Study of Tuberculosis," Vol. LX; also in later articles.

The lesion consists of an *isolated, rounded focus of varying density, usually situated just below the clavicle, in the lateral part of the pulmonic field,* more rarely in the lower portion of the upper lobe. Such a lesion is usually sharply circumscribed and definitely contrasted, but it may have little density and show a gradual transition into the normal pulmonic field illumination. It is of fundamental importance to understand that, in contradiction to the generally accepted idea that tuberculosis of the lungs nearly always begins in the apices, the type of lesion described, the infraclavicular focus, is associated with absolutely normal apices.

The observations were made mainly on young medical assistants from the clinic and the pathological department, and also on several nurses, their ages varying from 20 to 30 years. In all the cases there had been, shortly before the onset of disease, sufficient exposure for infection with tubercle bacilli. Later, to a lesser extent, however, similar observations were made on individuals of other occupations. The reason for the preponderance of the observations of this disease among medical men and nurses is probably that, as confidential physician, I was consulted very early in the disease when there were only minimal symptoms and when only a suspicion of the presence of any infection existed. On the other hand, individuals of other occupations and not so related to a physician rarely seek advice and consultation for very slight symptoms, and thus such individuals are seen only when the disease is in an advanced stage. In such cases no deductions can be drawn as regards the original focus. Besides this, the frequency of this lesion in physicians and nurses may be explained by the fact that they are much more exposed to the infection than the ordinary individual. That such foci, however, are not infrequent in individuals of other occupations has been proven by Redeker as a result of careful examinations of cases of early tuberculosis

[1]The complete original article was published in the *Klinische Wochenschrift*, 1927.

(Brauer's "Contributions to Tuberculosis," Vol. LXIII, and elsewhere).

The discovery of these early infraclavicular infiltrations is of considerable theoretic significance, inasmuch as it is of value in the study of the primary seat of the disease from which extension of the lesion takes place unless it is treated in time. This focus has also a great practical importance, because with timely, early treatment the impending danger of a general infection can be averted and a complete cure assured in the majority of cases.

For the roentgenologic diagnosis it is necessary that the focus be sought during fluoroscopy. It may easily be hidden by the shadows of the scapula and the thoracic muscles. It is, therefore, to be recommended, in order to clear up the peripheral parts of the pulmonic fields from these extraneous shadows, to examine the patient in all aspects, including the oblique, with the arms rotated, and in the dorsoventral as well as ventrodorsal direction. The areas of infiltration are often shown more distinctly on the film than on the fluoroscopic screen.

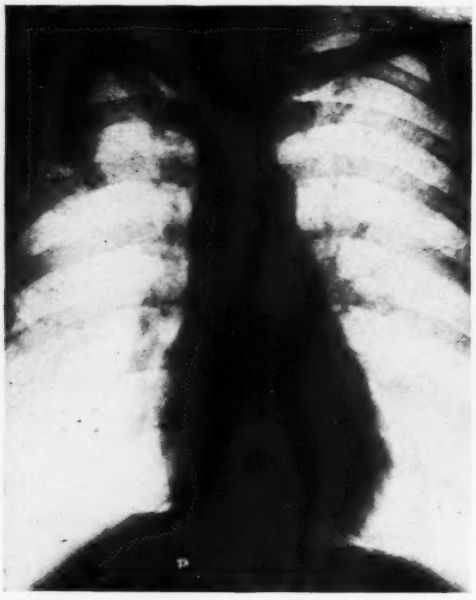


Fig. 1. Right infraclavicular focus. The patient is a young pathologist. Because of unsuitable treatment, and failure to induce pneumothorax, which I had recommended, a general phthisis developed. Death followed in six months.

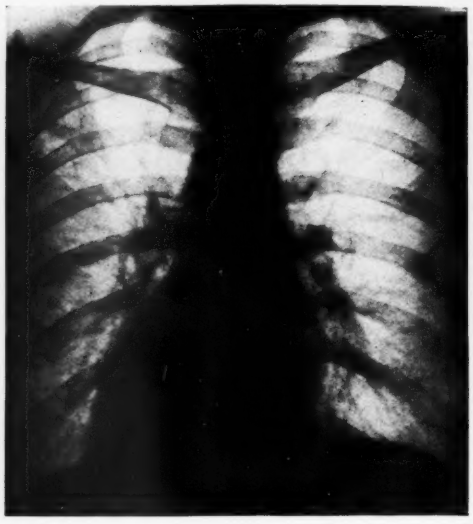


Fig. 2. Left infraclavicular focus, the patient being a female student, who, while in apparently good health, had a small hemorrhage. Below the clavicle near the periphery of the pulmonic field is a localized area of infiltration which has undergone caseation and cavitation. A short period of sanatorium treatment failing to produce results, a pneumothorax was induced.

Lateral views indicate that the foci are situated beneath the anterior or posterior surface of the lung, but usually in the median posterior portion of the upper lobe. The focus lies as a rule in the neighborhood of the lateral and dorsal bronchial ramifications of the subapical branch of the posterior upper lobe of the bronchus.

This position of the focus, at a distance below the surface, is responsible for very few or no physical signs. Only occasionally is it possible to elicit a change in the respiratory sound or fine râles in the interscapular region posteriorly, and rarely these signs may be elicited over the infraclavicular region anteriorly. The axillary region should

be examined thoroughly, though signs even in this space are rare. A slight lagging of the respiratory movement of the involved infraclavicular area is a frequent sign which will be noted by careful inspection.

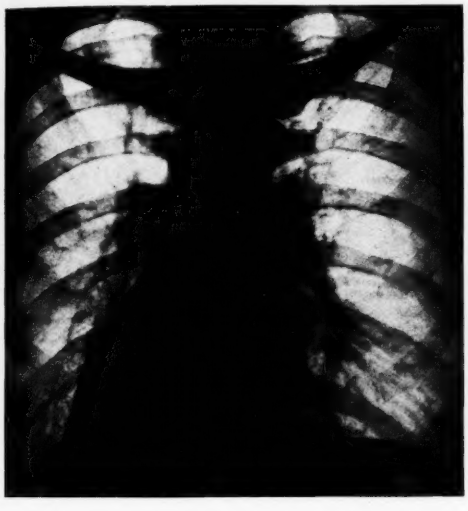


Fig. 3. The same case as shown in Figure 2, one year after the termination of a two-year treatment by pneumothorax. The infraclavicular shadow and cavity have disappeared except for a small, delicate linear shadow which can be recognized only on the original radiograph. There has been a complete return to normal health.

The general clinical signs are also often only minimal. There is sometimes a slight rise in temperature, but usually there is weakness and general malaise which brings the watchful patient to the physician. Unless a careful examination is made, the symptoms are generally attributed to a grippe infection. Sometimes a small hemoptysis in an apparently healthy individual is the first symptom of the disease. There may be slight pains in the chest, probably due to an associated local pleurisy. This is indicated less by direct symptoms than by the fact that after a pneumothorax adhesions are often found in these areas below the clavicula, the apices being entirely free. Expectoration is usually but minimal, so that even intelligent patients may not attach any importance to the symptom. However, even the most scanty sputum should be examined, because often it contains numerous tubercle bacilli.

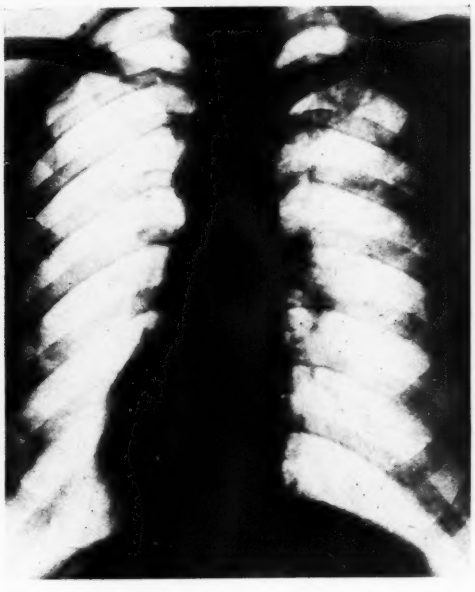


Fig. 4. Right infraclavicular circular shadow cavity. The patient is a nurse. In the second intercostal space near the edge of the pulmonic field, there may be seen a definite, thick ring shadow, indicating a cavity. Sanatorium treatment produced complete retraction of the cavity, leaving merely the linear shadow of the scar.

I have assumed the anatomic basis of the lesion to be *beginning tuberculous pneumonic infiltration, i.e., an exudative process.* This exudative process leads often, but not always, to caseation and central necrosis. This can be deduced from the fact of a *central illumination* and later *the formation of circular shadows with a light center.* With few exceptions these are produced by cavities. In a number of cases I have by autopsy confirmed the presence of these cavities and demonstrated the fallacy —frequently expressed in the literature—of interpreting such an appearance as inter-

lobar pneumothorax. In two cases I have confirmed by postmortem examination an *exudative pneumonic focus* with a caseating center to be the anatomic cause of the roentgenologic appearance.

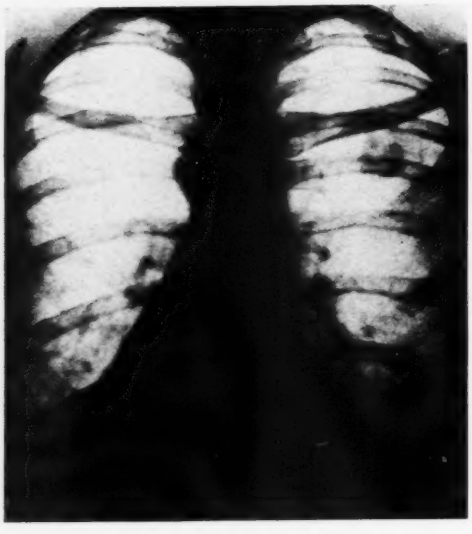


Fig. 5. Right infraclavicular focus, dorsoventral view.

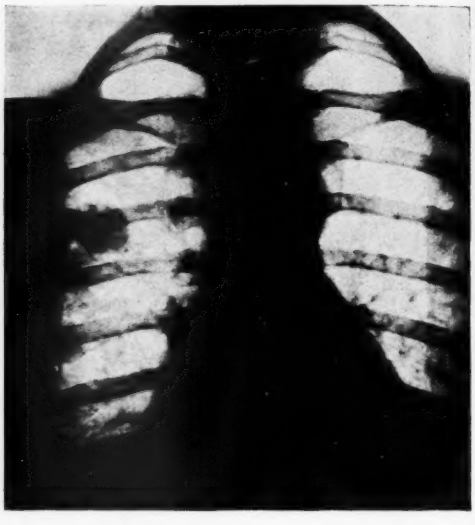


Fig. 6. The same focus as shown in Figure 5, ventrodorsal view.

In reference to the development and extension of these foci, it may be said that even in early cases there can already be found many evenly arranged, small foci around the primary lesion. These are to be considered to be small nodules originating from deposits of tubercle bacilli, carried by the blood vessels and lymphatics. In cases which have progressed further, in particular those which have not been subjected to treatment, there may sometimes be seen a progressive, continuous extension from the main shadow of the focus, and sometimes the appearance of similar isolated, rounded foci in other portions of the pulmonic field, which are to be considered as *aspiration metastases. Thus the familiar picture of phthisis of the lungs may develop from the early infiltrations and infraclavicular foci.* This does not imply, of course, that pulmonic phthisis originates in all cases from such a lesion as I have described. This must be emphasized. It is an unwarranted generalization from my description of this lesion. The decision of the question as to how often pulmonary phthisis develops from such infraclavicular foci, and how often it originates from apical foci, as is generally believed, cannot as yet be rendered. The answer to these questions will require many years of careful observation of such early cases.

Even if the foci I have described are the first apparent signs of the disease in certain cases, it is not to be inferred that they are evidences of the very first infection, in other words, true primary foci according to Ranke and Cohn. Such a supposition would hardly be tenable because of the probability that among city dwellers, from which social class my patients come, a tuberculous infection (which is, however, overcome, in most instances) takes place in early childhood. The positive von Pirquet reaction and other tests for tuberculosis in those of

advanced age, in contrast to the results during childhood, speak for this. There is also only a slight involvement of the lymph glands of the hilus to be observed during the disease, in contrast to the marked adenopathy and caseation which always occur with the true primary focus of childhood and which belong to the primary complex of Ranke. In my opinion the infraclavicular foci of young adults indicate, therefore, a *reinfection*, such as may occur in a subject not entirely free from tuberculosis, yet one practically healthy and normal. The infection probably occurs in an aërogenic manner; only in rare, isolated cases may it be assumed to be of a hematogenic origin.

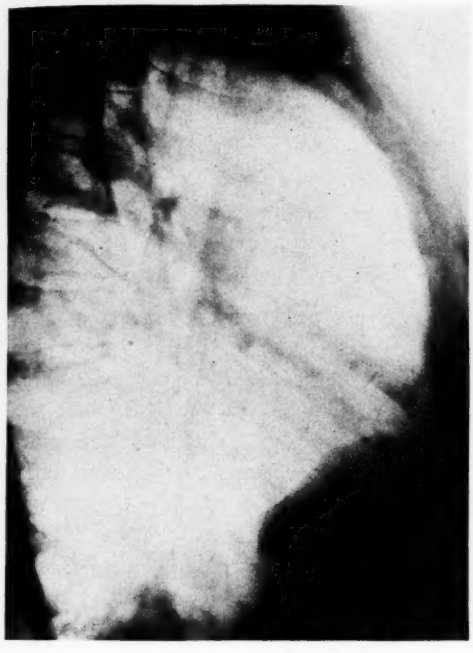


Fig. 7. The same focus as shown in Figures 5 and 6, frontal view.

For further theoretical questions which cannot as yet be definitely solved, especially regarding the immune biological relation of these foci, I must refer the reader to the German literature where I have discussed the subject, and also to the works of other authors (Redeker, Lydtin and others).

The prognosis as to the infraclavicular foci and other early infiltrations is *usually favorable* when the right treatment is given; in several neglected cases, however, I have seen a spread of the disease and an unfavorable issue.

Fig. 8. Large early infiltration in the left upper lobe. The outline of the area of infiltration is not sharply circumscribed.

In a series of cases observed, a considerable resolution toward normal radiographic appearance was apparent on serial films. The shadows of such a focus may diminish considerably, even the circular shadows of the cavities may shrink in a striking manner and finally disappear entirely, leaving only a very small linear scar. This healing takes place partly through resorption of the exudative pneumonic process, and partly through fibrosis, with consequent retraction of the scar. With timely as well as energetic treatment, therefore, a favorable prognosis may be made. Among my patients there are several physicians and nurses, who, after the termination of treatment, are now fully active in their occupations and feel entirely well.

Even *without treatment* a healing of the infraclavicular foci of infiltration may occur. This is shown by the finding of sharply outlined shadows in this region as a practically unimportant secondary observation in cases of apparently healthy individuals who have no knowledge of any disease of the lungs. These areas usually have definite and distinct, sharply circumscribed shadows, the result of fibrosis or calcification.

The treatment is either general, dietary, and climatic, the latter preferably in a high mountainous region for a sufficiently long duration, or consists of the induction of a pneumothorax (with the unilateral form of the disease). In most cases in which the lesion is entirely confined to the infraclavicular region and in which a climatic-dietary treatment is possible, this should be tried first. However, it is necessary to observe carefully whether or not the process tends to retrogress, as it usually does. If it does not, especially if the cavities do not diminish rapidly, or particularly if an extension of the process into the surrounding regions or aspiratory metastases appear, or if continuous, abundant tubercle bacilli are found and the danger of aspiration is therefore great, a pneumothorax is to be promptly induced. When for economic reasons a long and expensive rest cure is not possible, or when large cavities are present, pneumothorax is to be induced immediately after the findings have been accurately demonstrated.

Because of the great theoretical and practical significance which the infraclavicular foci and similar early infiltrations have, I suggest the careful observation of the infraclavicular region, that an early diagnosis may be made and immediate treatment be instituted.

SUMMARY

In incipient tuberculosis of the lungs in young adults there are foci of infiltration which in certain cases can be recognized only by a roentgen examination, and which are situated in the infraclavicular region, more rarely in the lower parts of the upper lobes. From these foci a general tuberculosis may develop. With timely treatment, however, a favorable prognosis may be given. Early diagnosis and immediate, energetic treatment in the early stages are the ends for which one should strive.

THERMAL EFFECTS OF DIATHERMY

By ALLAN HEMINGWAY, PH.D., Departments of Physics and Biophysics and Physiological Chemistry, University of Minnesota, MINNEAPOLIS

IN diathermy the tissues of the human body are traversed by alternating electric currents of such high frequency that no faradaic stimulation of the tissue takes place, the non-stimulation being due, according to Nernst (1908) and Hill (1910), to the relatively small motion of the electrolytic ions in the rapidly alternating electric field. All investigators in the field of diathermy attribute the physiological effects of the high frequency current to the production of heat within the tissues. Sellheim (1910), using a mercury thermometer, and Furstenberg and Schemel (1912), a platinum resistance thermometer, in body cavities between the electrodes, have shown that the heating effect takes place in the deeper tissues. Lonergan (1927), and Binger and Christie, using thermocouple needles with apparatus similar to that described by Clark (1922), and using anesthetized dogs, have demonstrated the effect of the blood circulation on the temperature distribution in the deep-lying tissues in diathermy. From the experiments of Deesen (1913) and Maccleod (1920) it is seen that diathermy is more efficient in heating the deeper tissues than surface-heating methods. The heating of the tissue is attributed to the joule effect of the electric current, when the heat energy given to any conductor per second is I^2R, I being the heating current and R the resistance of the conductor.

In the diathermy machine used in clinical practice the ammeter in series with the patient is the sole method of determining the diathermy dosage. This will not enable one to determine the heat energy given to the patient if the resistance of the patient is not known, but it is useful in setting an upper limit to the current to prevent burning of the skin at the electrodes. In many cases the electrode is small in comparison with the section of the body to which it is applied. Thus there will be a converging of the current stream lines at the electrode, and, the current density being greatest at that place, the greatest heating will occur there. This is especially the case if there is a thick layer of subcutaneous fat of high resistance beneath the skin at the electrode, as Wildermuth (1911) has shown that fat has a higher specific resistance than other tissue.

For many years it was assumed that the current as registered by the milliamperemeter gave the true heating current. This conclusion was perhaps based on the experiments of Nesper (1910), who measured the current and voltage when dead animal tissue and a non-inductive resistance of the same value as the dead animal tissue were in the circuit. He found that the tissue behaved as a pure resistance and concluded from this that the capacitative effect was small. However, the resistance used was small, the frequency of the machine used was low (300 kilocycles), and the measurements were not calorimetric. Recently, d'Arsonval (1927), from calorimetric measurements with solutions of salts and body fluids, came to the conclusion that the diathermy ammeter did not register the true heating current. In this he was supported by the calculations of Fabry (11). D'Arsonval passed the diathermy heating current between two bright platinum electrodes, 4×2 square centimeters, in a beaker of solution and observed the temperature increase of the solution for a 500-milliampere current during a two-minute interval. The resistances of the sodium chloride solutions used in the beaker varied from 13 to 35,000 ohms. For resistances

below 1,500 ohms he found that the heating effect increased with resistance, but decreased with resistance for increasing resistances greater than 1,500 ohms. The explanation of this result was that for high resistances the current as registered by the ammeter consisted for the most part of a wattless component, passing between the electrodes as between the plates of a condenser. Before one can apply this result to diathermy it is necessary to consider whether the system of the electrodes in the solution is a true electrical substitute for the patient in diathermy. For such a solution to represent a patient in diathermy the resistance of the solution between the electrodes must be of the same order of magnitude as that of the human body between the diathermy electrodes. Furthermore, the resistances must be measured at high frequency, that is, a frequency of the same magnitude as the high frequency diathermy heating current, as the resistances of both the solution and the human body decrease with increasing frequency.

A section of the human body between two diathermy electrodes may be represented as in Figure 1. In attempting to represent the equivalent electrical system, polarization capacity both at the metal-solution boundaries and at the cell membranes must be taken into consideration.

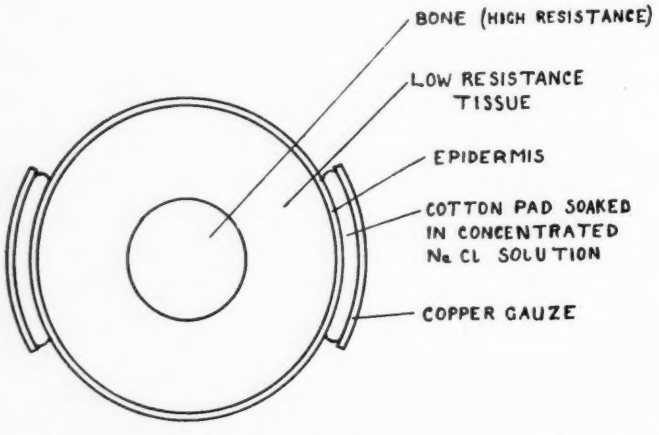


Fig. 1. A schematic drawing of a section of the human body between two diathermy electrodes.

Miller (26), Banerji (1), McClendon (23, 24, 25) and others picture the electrical equivalent of a polarization cell as a leaky condenser (a condenser in parallel with a resistance) in series with a pure resistance, the leaky condenser representing the Helmholtz double layer at the electrodes, and the series resistance, the true resistance of the solution. Gildemeister (16), McClendon (23, 24, 25) and others give a similar electrical representation for the tissue cells in an electrical field, a leaky condenser representing the cell membrane and the series resistance the cell interior. Einthoven (10) also points out that with high frequency alternating currents the epidermis of the skin, which, as many investigators have shown, has a very high resistance in comparison to the deeper tissue, acts as the leaky dielectric of a condenser, situated as it is between the well-conducting outer electrode, the solution (or metallic electrode),

and the well-conducting subcutaneous tissue. This leads to an electrical representation of the section of the human body between diathermy electrodes as given in Figure 2. C_A and R_A represent the leaky

$$R_F + (R_B + R_B') + (R_D + R_D'),$$

and since $(R_B + R_B')$ and $(R_D + R_D')$ are small, is approximately R_F, the resistance of the underlying tissue. Thus by in-

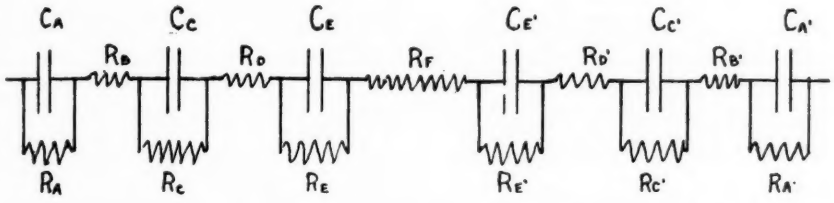


Fig. 2. An electrical representation of a section of the human body between diathermy electrodes

Helmholtz double layer at the solution-metallic boundary, while R_B is the true resistance of the solution between the epidermis and the metallic electrode, which is very low if the solution is concentrated. Cc and Rc represent the leaky condenser of the epidermis. This would be a parallel plate condenser of plates approximately the size of the electrodes and a distance apart equal to the thickness of the epidermis. R_D, C_E, and R_E represent the living cells of the skin, while R_F represents the resistance of the deep-lying tissue. The remaining capacities and resistances represent similar systems at the other electrode.

From alternating current theory the effective impedance of any leaky condenser of parallel resistance R and parallel capacity C is

$$Z = \frac{R}{1 + R^2w^2C^2} - j\frac{R^2wC}{1 + R^2w^2C^2}$$

where w is 2π times the frequency of the alternating current and j is the imaginary vector operator $\sqrt{-1}$. It is seen that when C and w are very large the impedance becomes small, as is the case at high frequency. Hence at high frequency the effective resistance of the electrical circuit of Figure 2 is

creasing the frequency, disturbing electrode and membrane effects are eliminated.

To investigate this problem further, the resistances of the human body between diathermy electrodes have been measured at high frequency (a million cycles per second) with two types of electrodes in position for the usual diathermy treatments. In this way the order of magnitude of high frequency diathermy resistances has been determined and solutions have been used whose high frequency resistances are of the same magnitude as the diathermy resistances. Joule's law (I^2R) has been tested experimentally for two different diathermy machines of frequencies 500 and 1,500 kilocycles.

Investigations have also been made to determine if there is any difference in thermal effects when the spark gap and the coupling inductance in the outer circuit containing the patient are varied, the current being kept constant. The frequency distribution of the current has also been studied with respect to its dependence on the resistance of the patient and the relative amounts of coupling inductance in the oscillating and external circuits.

The ammeter does not give an estimation of the heat energy given to the patient, because the resistance of the patient is not known. The only method of measuring the energy is to place a wattmeter in the primary circuit of the 60-cycle transformer. This would measure the total energy input which would be divided between heat energy given

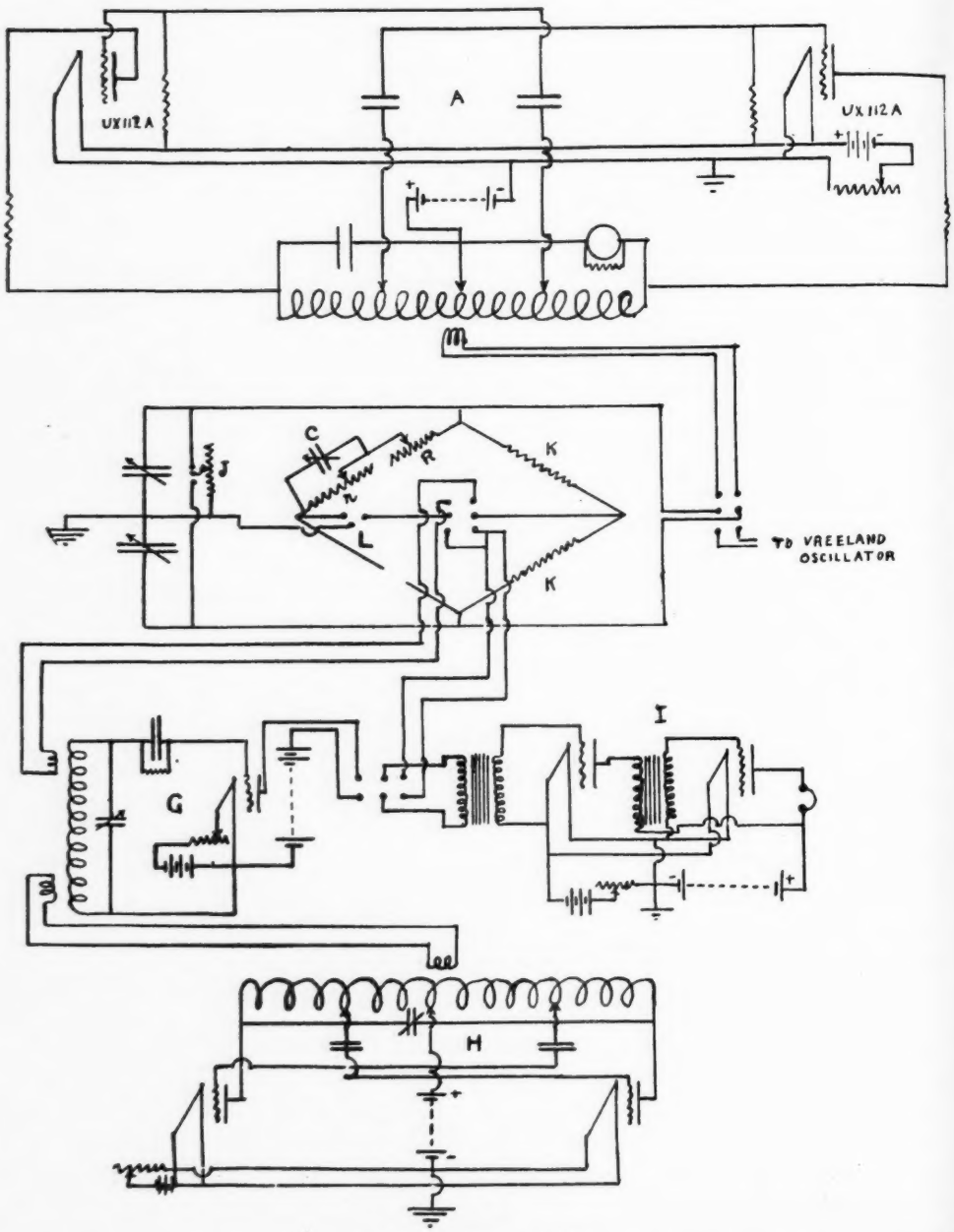


Fig. 3. Diagram of bridge.

to the patient and high frequency losses in the machine. The relation between the input energy and the heat energy given to the solution has been investigated for solutions with high frequency resistances of the order of magnitude of those of the patients in diathermy. The efficiency of the machine has also been investigated when the spark gaps are varied.

PART I.—ELECTRICAL RESISTANCE OF THE HUMAN BODY TO HIGH FREQUENCY DIATHERMY CURRENTS

The references to the measurement of the resistance of the human body occurring in the literature for the most part are concerned with the resistance to direct currents or low frequency alternating currents. Gildemeister (15), Einthoven (10), David (6) and others have studied the effect of voltage, duration of current, polarization, and frequency on the apparent resistance of the human body. Dowse and Iredell (7) have measured the impedance of the human body to high frequency currents, using the indications of a thermocouple ammeter and a non-polarizable electrolytic resistance for comparison, but have not given any values of the resistances occurring in diathermy. Dubost (9) describes a low frequency bridge using vacuum tubes suitable for measurements of the resistance of the human body. It is the purpose of the following experiments to determine the order of magnitude of the diathermy resistances in the human body such as occur in clinical treatments of diathermy.

For these measurements two methods were tried: (1) a resonance method using a circuit on the principle of that described by Sayce and Biscoe (31), and (2) a high frequency Wheatstone bridge method as designed by McClendon and Remington (1928). The bridge method was found to be more satisfactory for manipulation and more accurate in its results, so this method was used for the experiments.

A vacuum tube oscillator was used to produce the high frequency current of one million cycles per second. For detection, a heterodyne oscillator was used, with a detector circuit and a two-stage amplifier with a telephone. Separate shielding was used for each circuit, for the batteries of each circuit, for the resistance and capacity units, and for the ratio arms and connections. The only unshielded parts of the high frequency circuit were the electrodes and that section of the body between the electrodes. For audio frequencies a Vreeland oscillator was the current source, while the amplifier circuit alone was used in the bridge. A Wagner ground, as described by Stratton (33), was used to insure a symmetrical ground capacity and ground leak. With this bridge very satisfactory results were obtained, silence in the telephone being obtainable in every case when the patient was still, although the slightest movement on his part would upset the ground balance. A diagram of the bridge is given in Figure 3, but space does not permit further description, as this is given in detail in a paper by Remington (29).

The diathermy current was produced by a Kelley-Koett diathermy machine.[1] The frequency of the current was about fifteen hundred kilocycles per second. The high frequency current was measured by a Weston thermocouple ammeter, which is part of the equipment of the machine. In measuring the body resistance the electrodes were applied to the section of the body to be treated with diathermy. The leads to the bridge were first attached to the diathermy electrodes and the bridge balanced by a resistance in series with a capacity using a high frequency current of 10^6 cycles. This high frequency series resistance is denoted

[1]Kindly loaned for this purpose by the Kelley-Koett Company.

TABLE I

Experiment No.	Locality	Electrodes	When measured	Current ma.	High frequency series resistance ohms	High frequency series capacity μF	3.103 cycles/sec. r ohms	3.103 cycles/sec. C μF	103 cycles/sec. r ohms	103 cycles/sec. C μF
1	Left shoulder	Lead, 9 × 16 cm.	B	1100	28.0	0.05			705	0.590
2			A		28.0	0.06			705	0.620
3	Right shoulder	Lead, 9 × 16 cm.	B	1100	38.5	0.10	600	0.216	2250	0.245
4			A		37.0	0.15	350	0.465	1020	0.566
5	Right shoulder	Lead, 9 × 16 cm.	B	1100	28.0	0.10	600	0.269	2100	0.279
6			A		27.0	0.10	370	0.439	1140	0.521
7	Right shoulder	Lead, 9 × 16 cm.	B	1100	40.0	0.15	420	0.350	1400	0.410
8			A		40.0	0.15	390	0.393	1400	0.413
9	Right shoulder	Lead, 9 × 16 cm.	B	1100	36.0	0.08	300	0.437	820	0.420
10			A		33.0	0.09	430	0.332	850	0.370
11	Sacro-iliac region	Lead, 9 × 16 cm. back; 17 × 17 cm. front	B	1000	35.0	0.03	250	0.722	610	0.85
12			A		34.0	0.10	240	0.750	630	0.88
13	Right knee	Solution-soaked felt pad, 9 × 6 cm.	B	500	40.0	0.05			1507	0.44
14			A		37.0	0.05			2303	0.99
15	Left knee	Solution-soaked felt pad, 9 × 6 cm.	B	500	33.0	0.05			705	0.99
16			A		28.0	0.04			720	0.975
17	Left knee	Solution-soaked felt pad, 9 × 6 cm.	B	500	55.0	0.090	430	0.332	850	0.320
18			A		45.0	0.090	338	0.415	730	0.512

TABLE II

Experiment No.	Locality	Electrodes	When measured	Current ma.	High frequency series resistance R	High frequency series capacity	3.103 cycles/sec. r ohms	3.103 cycles/sec. C μF	103 cycles/sec. r ohms	103 cycles/sec. C μF
19	Sole to thigh	Bowl of solution, felt pad	B	500	195.0	0.08	193	0.245	367	0.432
20			A		162.0	0.03	200	0.258	363	0.450
21	Thigh to calf	Felt pad	B	500	44.0	0.09	285	0.400		
22			A		45.0	0.09	290	0.410	495	0.433
23	Calf to sole	Felt pad, bowl of solution	B	500	146.0	0.04	215	0.325	494	0.472
24			A		133.0	0.10	224	0.340	490	0.474
25	Sole to thigh		B	500	197.0	0.06	200	0.236	370	0.413
26			A		173.0	0.07	210	0.228	410	0.400
27	Thigh to calf		B	500	52.0	0.06	255	0.355	500	0.460
28			A		47.6	0.08	280	0.370	700	0.485
29	Calf to sole		B	500	157.0	0.021	255	0.255	515	0.385
30			A		140.0	0.06	255	0.280	555	0.400
31	Right shoulder	Lead, 10 × 7 (cm.²)	B	1000	36.0	0.07	336	0.240	800	0.355
32			A		33.0	0.08	175	0.520	300	0.690
33	Right shoulder	Pad electrodes, 10 × 7 cm.	B	1000	35.5	0.08	230	0.410	450	0.610
34			A		33.0	0.08	115	0.363	235	0.920
35	Right shoulder	Lead electrodes, 10 × 7 cm.	B	1000	34.0	0.08	410	0.280	900	0.346
36			A		33.5	0.04	217	0.392	406	0.535
37	Right shoulder	Pad electrodes, 10 × 7 cm.	B	1000	34.0		215	0.505	285	0.715
38			A		32.0		120	0.760	230	1.00

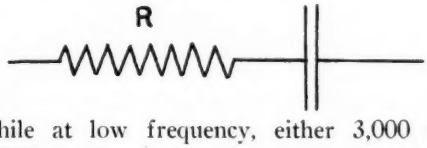
in the following data as "R." The high frequency current was then discontinued and the low frequency current used. With R still in the known arm as a series resistance, silence was obtained in the 'phones by varying the parallel resistance r and the parallel capacity C. The low frequencies used were 3,000 and 1,000 cycles per second.

After the initial readings were taken the bridge leads to the patient were disconnected and the cables from the diathermy machine connected to the electrodes. A current prescribed by the hospital physician was then passed for 20 minutes through the part of the body to which the electrodes were applied. After the treatment the diathermy current was discontinued and the electrodes were again connected into the unknown arm of the bridge, the high frequency series resistance R and the capacity were obtained, then the low frequency parallel capacity C and the parallel resistance r in series with R were determined in the same manner as before the treatment.

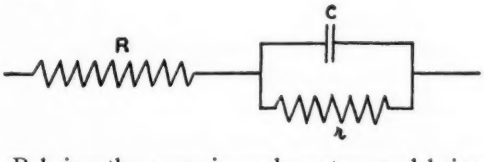
In diathermy two types of electrodes are in common use: (1) pliable lead electrodes, and (2) felt pad electrodes about one-half of one centimeter in thickness and soaked in a concentrated sodium chloride solution, with a copper gauze covering the back of the electrode to which cables from the machine are attached. Bordier (1928) has observed apparently greater physiological heating effects with the metallic electrodes. In order to determine if this difference is due to a difference in resistance the following experiment was performed.

Pliable lead electrodes of area 10×7 square centimeters were placed in front and behind the shoulder and pressed to the skin by sand bags. The resistances were then measured. These metallic electrodes were then replaced by pad electrodes of the same area and the resistance again measured. A diathermy current of 500 milliamperes was then passed through the shoulder for 20 minutes and the resistance again measured. The pad electrodes were removed and replaced by the original lead electrodes, a 500-milliampere current was passed through the shoulder for five minutes and the resistance between the lead electrodes measured. The results are given in measurements 31-38 of Table II.

Results.—The resistance measurements are contained in Tables I and II. The second column gives the section of the body to which the electrodes were applied. The third column gives the type and surface area of the electrodes used, the two types being the pliable lead electrodes and the solution-moistened pad electrodes covered with copper gauze. The letters "B" and "A" in the fourth column indicate whether the resistances were measured before or after the diathermy treatment. In the fifth column the high frequency current is given in milliamperes. As already mentioned, the resistance capacity arrangement in the balancing arm at high frequency was



while at low frequency, either 3,000 or 1,000 cycles per second, the arrangement was



R being the same in each system and being first determined at high frequency.

In Experiments 1-18 resistance measurements were made on various persons on different sections of the body. Measurements 1-10 were made on four different persons, 7 and 8 and 9 and 10 on women, while 1-6 were made on two men. Measurements 2-6 were made on one man, 5 and 6 being measured two days after 3 and 4. In

11 and 12 the resistance of a woman through the abdomen was measured. In 13-18 the transverse resistances of a woman's knee were measured, using pad electrodes placed one on either side of the joint. Measurements 17 and 18 were made two weeks after 15 and 16. The large difference in high frequency resistance between these two sets may be due to the fact that the electrodes in the second setting may not have been placed coincident with the first setting. At the knee joint a slight change in position would move an electrode from a bony section to a part with more fleshy tissue beneath the skin.

In Tab'e II, Measurements 19-24 give the longitudinal resistances of the joints. The sole of the foot was placed on a felt pad in a shallow bowl of concentrated sodium chloride solution with the sole just beneath the surface of the solution. The cables from the diathermy machine or bridge were connected to a large lead plate immersed in the solution. Pad electrodes 3 centimeters wide, soaked in concentrated sodium chloride solution, encircled the leg above and below the knee. The diathermy cables were attached to the upper and lower electrodes, thus heating both knee and ankle, while resistance measurements were taken of knee and ankle together, 19 and 20 and 25 and 26, of the knee 21 and 22 and 27 and 28, and of the ankle 23 and 24 and 29 and 30. Measurements 25-30 are identical in manipulation with 19-24 but were taken two days later.

In comparing the types of electrodes Measurements 31-38 were taken. Measurements 31 and 32 and 35 and 36 give the resistances when pliable lead electrodes were used, while 33 and 34 and 37 and 38 are the resistances using identical saline pad electrodes. Measurements 35-38 were taken under similar conditions to 31-34 but two days later.

Discussion of Results.—These figures prove that the high frequency series resistances encountered in diathermy are very low in comparison with the low frequency measurements. The general order of magnitude of high frequency series resistances is from 20 to 200 ohms, with the greater portion in the region 20 to 60 ohms. The resistances through the body, *i.e.*, the shoulder and abdomen, are low in comparison with the resistances of the joints of the limbs, which are of the order of 60 to 200 ohms. The resistance of the knee with electrodes placed one on either side is about 60 ohms.

The high frequency resistance is practically the same whether pliable lead or felt electrodes soaked in concentrated sodium chloride solution are used. It is to be expected, then, that with the same current the same amount of heat energy would be given to the patient if the electrode area and position on the body were the same for each type of electrode. The low frequency values show a variation for different types of electrodes, but in practice we are not concerned with these. They give an estimation of the magnitude of the polarization effects and illustrate the necessity of taking measurements at the same frequency as that of the diathermy current.

The longitudinal high frequency resistances of the knee and ankle, taken together by measuring the resistance from the thigh to the sole, are slightly less than the sum of the longitudinal resistances of knee and ankle separately as measured by the electrodes already described. However, this is what we would expect as the sum of the current paths over the individual sections would be longer than over the total section. When a current passes from the thigh to the sole of the foot the ankle and knee resistances give an estimation as to how the heat energy is distributed in the joints as well as the order of magnitude of this energy.

The values of the low frequency parallel

resistances and capacities will give one an approximation as to the skin resistance and contact resistance at the electrodes. The large change of capacity from high to low frequency fits well the assumptions of Gildemeister (15) and Galler (13) that this is a polarization capacity. If the electrodes were pressed close to the skin but made a poor contact, at high frequency the current would jump the poor contact in the same way that a current passes a condenser due to the low high frequency reactance factor. Gildemeister (17) mentions that it is in this way a large high frequency current passes the high electrical resistant epidermis. But the capacitative reactance would be large at low frequency, and more of the current would pass through the leak resistance rather than as a wattless current through the condenser. Usually with metallic electrodes the low frequency parallel resistance (r) is greater before the treatment than afterward. This is to be expected, since, due to the heat from the high frequency current, excess sweat secretion is produced. This sweat collects beneath the electrodes and forms a better contact than that between the electrodes and the dry skin.

With saline electrodes, in some cases a decrease in low frequency parallel resistance (r) takes place, due to the diathermy treatment. The electrodes at the beginning of a treatment were saturated with concentrated sodium chloride solution. They were then pressed close by rubber bands or sand bags to the part of the body to be treated. This had a tendency to squeeze out some of the concentrated sodium chloride solution. When the electrodes were placed against the sides of a vertical limb, as was usually the case, the solution would leak away or collect at the lower edge of the electrode, due to gravity. Then the general warming on the passage of the diathermy current caused evaporation to take place so that the electrodes, or at least part of them, had a tendency to dry out. This fact is generally known to physicians and accounts for any increase of contact resistance resulting from a diathermy treatment.

The decrease of high frequency series resistance (R) on diathermy treatment may be partly due to the increased conductivity of the tissues resulting from an increase in temperature. The increased blood circulation due to the heating effect may also produce a fall in resistance. It is doubtful whether the large (5 to 20 per cent) decrease in high frequency resistance can be ascribed to the temperature coefficient of an electrolyte, as later temperature-resistance curves will show.

The problem of measuring definite body resistances, their change under diathermy treatment, the influence of the size of electrodes, and the persistence of the resistance change after treatment remain to be worked out statistically from measurements taken on a large number of patients. The results obtained here give one a rather qualitative idea of what to expect from such measurements. However, the results of these measurements have served their purpose—they give us the order of magnitude of the high frequency diathermy resistances, values hitherto unknown, and to obtain them these experiments were undertaken. It follows, then, that it would be erroneous to substitute an electrolytic resistance of more than 500 ohms for a patient in diathermy.

These high frequency resistances are, then, the effective resistances to high frequency currents, and we are led to believe that such resistances cause the heating effect. It is the purpose of Part II of this paper to investigate this matter, namely, if, knowing the high frequency resistances of solutions and the high frequency heating current traversing the solution, the joule heat relation I^2R will give the heat produced.

PART II

In Part I the resistances of patients to high frequency currents of approximate

diathermy frequency have been measured under conditions occurring in diathermy treatments. From the theory of Gildemeister and others, it has been shown that for purposes of measurement in diathermy electrolytic solutions may be used as a substitute for the patient only when measurements of both patient and solution are made at high frequency, in order to obtain the true resistance without disturbing polarization effects. In the following experiments solutions have been used whose high frequency resistances were of the order of magnitude of the high frequency resistances of the patients in diathermy, namely, 20 to 200 ohms. These solutions in a calorimeter have been substituted for the patient in a diathermy circuit, and the heat energy given to the solution during a given time measured calorimetrically and compared with the I^2R value, where I is the current as measured by an ammeter in series with the solution and R is the high frequency resistance. Two different diathermy machines have been used, of frequencies 500 and 1,500 kilocycles. The description of the apparatus, the methods used, and the results obtained are given in this section.

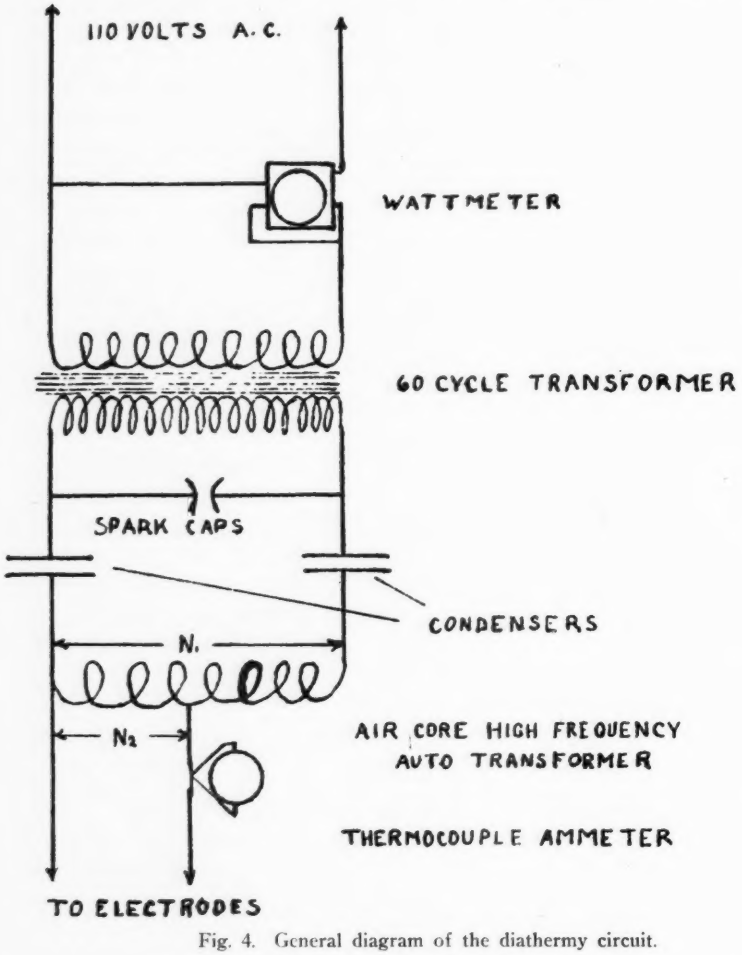


Fig. 4. General diagram of the diathermy circuit.

Diathermy Machines.—In clinical practice diathermy machines of different fre-

quencies are used. It is the purpose of the following experiments to determine whether or not there is any difference in the amount of heat energy given to the patient as indicated by the milliamperemeter for a 500 and a 1,500 kilocycle machine.

For the higher frequency a 1,500-kilocycle Kelley-Koett machine was used.[2] For the 500-kilocycle machine a set was built up in the laboratory, using mica condensers and a 1:100 turn ratio half-kilowatt transformer.[3] The general diagram of the diathermy circuit is shown in Figure 4, which is the circuit in general use in diathermy machines. Both machines used were designed on this principle, the capacity and inductance of the 1,500-kilocycle being less than that of the 500-kilocycle machine in the oscillating circuit. In each case the "external" circuit containing the patient (or solution) and the ammeter was directly coupled to the inductance of the oscillating circuit. In the following experiments the circuit containing the patient was connected across one-half of the inductance of the oscillating set, or, in terms of the letters of the diagram of Figure 4,

$$N_1 = 2\,N_2$$

where N_1 represents the number of turns of the inductance in the oscillating set and N_2 the number of turns of coupling inductance in the external circuit containing the patient.

To measure the current passing through the solution two ammeters were used. One of these was a thermocouple ammeter using a Western Electric vacuum thermocouple with a Weston micro-ammeter which was calibrated with direct current. The other ammeters were those belonging to the respective commercial diathermy machines.

Calorimeter.—The solutions were placed in a Gaertner calorimeter in a glass container (G), as in Figure 5. The wound wire cables (W) carrying the diathermy current to the electrodes passed through glass tubes filled with paraffin (P), to the brass connections (A), through which a tungsten wire about one millimeter in thickness passed to the electrodes (E). These electrodes, which were of platinum foil 4×4.5 square centimeters in area, were welded to a tungsten frame on the back of the electrode and were placed 5 centimeters apart. The back of each electrode and the brass connections were covered with a thin coating of paraffin. S is the stirrer, C the wooden cover of the calorimeter, and B a Beckmann thermometer, which was in some cases replaced by a thermocouple. From determinations of the specific heat of electrolytes, as given by Richards and Rowe (30), as well as the earlier results of Marignac (*22*), the solutions used were sufficiently dilute so that their specific heat could be considered as unity. The heat capacity of the system of electrodes, container, and solution was computed to be 2,130 calories per degree.

Resistance Measurements of Solutions.—In order to have minimum radiation losses the experiments were performed within two to three degrees centigrade of the temperature of the surroundings, *i.e.*, the temperature as indicated by the thermometer (T) in Figure 5. As the temperature of the solution is increased, due to the heating by the diathermy current, the resistance will decrease and in the calculation of I^2R the mean resistance will be used.

Potassium chloride solutions were then prepared whose high frequency resistances were approximately 20, 40, 60, 100, and 200 ohms, and their resistances determined in the calorimeter for every degree between 16 degrees and 25 degrees centigrade. A curve was then plotted of resistance variation with temperature for each solution, and from this curve the resistance could be ob-

[2]Kindly loaned to us for this purpose by the Kelley-Koett Company.

[3]A set of spark gaps and a thermocouple ammeter used on this machine were loaned to us by the Victor X-Ray Company.

tained at any temperature between 16 and 25 degrees centigrade. Two resistance measurements were made: (1) at a frequency of 10^6 cycles per second, using a resistance and capacity in series in the balancing arm, and (2) a low frequency measurement at 1,000 cycles per second, using a resistance in parallel with a capacity, the usual Kohlrausch method. The Wheatstone conductivity bridge, as described in Part I, was used for these measurements. In general, the high frequency series resistance was 25 per cent lower than the low frequency parallel resistance obtained by the Kohlrausch method for the same solution.

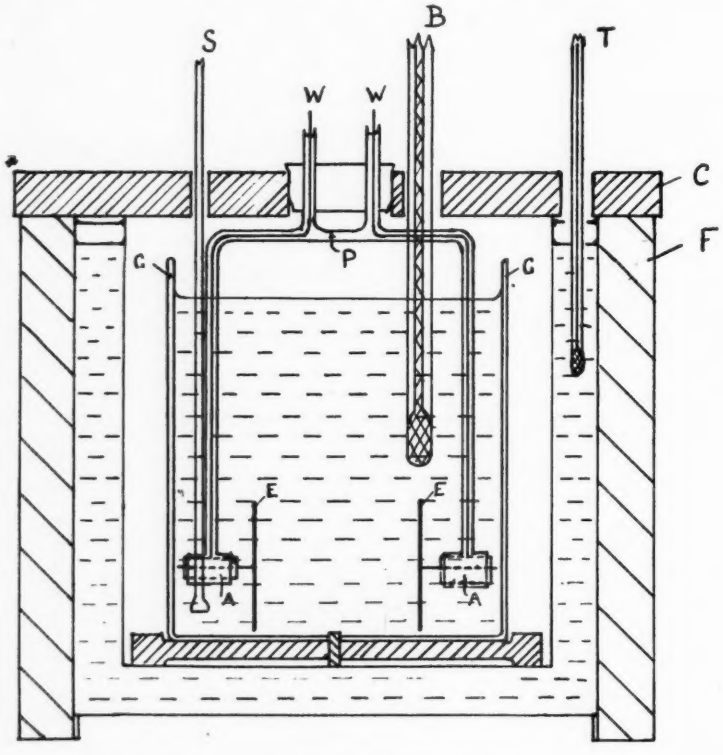


Fig. 5. The solutions were placed in a Gaertner calorimeter in a glass container (G).

Calorimetric Measurements.—In taking the calorimetric measurements the high frequency current was passed between the electrodes for a given length of time, the temperature increase noted, and the rate of increase of energy calculated and compared with the $\bar{I}^2\bar{R}$ value, the average resistance ($\bar{R}$) being obtained from the temperature-resistance curves, while $\bar{I}$ was the average current as registered by the ammeter.

The solution was first cooled—or heated—placing it two to three degrees below the temperature of the water in the outer jacket of the calorimeter, and the current through the solution adjusted by means of the resistance or inductance in the primary circuit of the low frequency transformer. The current was then discontinued and the solution stirred for five minutes, until thermal equilibrium was obtained. The temperature of the solution was then noted and the thermocouple reading taken. The high frequency diathermy current was then

passed through the solution for a given time interval. The current was read from the ammeters at the beginning and at the end of a run, a slight increase of current being sometimes noticed, due to the decrease of electrolytic resistance on heating the solution. With the vacuum thermocouple-micro-ammeter system the micro-ammeter was read and the corresponding values of the direct current (I_D) obtained from the

TABLE III

SOLUTION IN PARALLEL WITH ONE-HALF OF INDUCTANCE 1,500-KILOCYCLE DIATHERMY MACHINE

$\bar{I}_D$ Equivalent D. C. heating current	$\bar{I}_K$ Current reading of diathermy ammeter	$\bar{R}$ Average high frequency resistance ohms	$\frac{\Delta H}{\Delta t}$ watts	$\bar{I}_D^2\bar{R}$ watts	$\bar{I}_K\bar{R}$ watts	$\frac{\frac{\Delta H}{\Delta t}}{I_D^2R}$
		0.314 per cent KCl Solution				
0.834	0.825	19.0	14.0	13.0	12.8	1.08
0.697	0.690	19.4	10.1	9.4	9.4	1.08
0.553	0.535	19.8	6.1	6.06	5.7	1.00
		0.139 per cent KCl Solution				
0.815	0.800	42.4	25.2	28.2	27.1	0.90
0.670	0.650	42.5	17.3	19.0	17.9	0.91
0.490	0.470	43.0	9.3	10.3	9.5	0.90
		0.105 per cent KCl Solution				
0.795	0.780	60.2	36.5	38.2	36.7	0.96
0.680	0.655	58.9	25.2	27.2	25.3	0.93
0.485	0.470	59.8	13.2	14.0	13.2	0.94
		0.059 per cent KCl Solution				
0.840	0.815	98.6	64.4	68.6	65.5	0.94
0.727	0.705	96.8	46.3	51.2	47.3	0.90
0.558	0.542	95.3	26.5	29.0	28.0	0.90
		0.026 per cent KCl Solution				
0.826	0.800	175.5	103.3	119.7	112.0	0.86
0.714	0.695	177.9	79.8	90.7	85.9	0.88
0.568	0.555	180.5	52.6	58.3	55.6	0.90

TABLE IV

500-KILOCYCLE DIATHERMY MACHINE

$\bar{I}_D$ amps.	$\bar{I}_V$ amps.	$\bar{I}_Z$ amps.	R ohms	$\frac{\Delta H}{\Delta t}$ watts	I_D^2R watts	I_V^2R watts	I_ZR watts	Watt-meter reading watts	$\frac{\frac{\Delta H}{\Delta t}}{I_D^2R}$
			0.314 per cent KCl						
0.820	0.845	0.820	20.9	14.5	14.1	14.9	14.9	28	1.02
0.684	0.700	0.680	19.8	9.9	9.3	9.7	9.15	20.5	1.05
0.550	0.525	0.515	20.4	6.9	6.17	5.7	5.4	15	1.11
			0.139 per cent KCl						
0.810	0.830	0.810	44.3	28.7	29.1	30.5	29.1	55	0.99
0.700	0.710	0.675	42.0	19.9	20.3	21.1	19.4	38.5	0.98
0.530	0.510	0.495	43.0	12.0	12.3	11.2	10.8	25	0.98
			0.105 per cent KCl						
0.840	0.855	0.845	61.8	45.3	43.6	45.2	44.0	87	1.01
0.684	0.685	0.670	58.1	27.0	27.2	27.4	26.1	54	0.99
0.540	0.525	0.510	59.8	17.8	17.4	16.8	15.6	34	1.02
			0.059 per cent KCl						
0.810	0.810	0.800	97.8	59.5	64.2	64.2	62.6	122	0.93
0.685	0.685	0.660	93.1	38.6	43.7	43.7	40.5	82	0.89
0.542	0.530	0.515	95.1	25.0	27.8	26.7	25.2	49	0.90
			0.026 per cent KCl						
0.630	0.625	0.600	179.5	69.8	71.3	70.2	64.6	195	0.98
0.540	0.525	0.500	183.1	52.5	53.4	50.4	45.8	132	0.98
0.462	0.440	0.410	186.9	39.3	39.7	36.2	31.4	90	0.99

direct current calibration chart. With the commercial ammeters the current was read directly from each instrument, that from the 1,500-kilocycle machine being designated as "I_K" and that from the 500-kilocycle machine as "I_V" or "I_Z." Average values for a run have a bar placed over them, as "$\bar{I}_D$." When the temperature had increased from 0.5 to 1.0 the heating current was stopped, and after waiting one to two minutes for equilibrium the temperature and the thermocouple galvanometer reading were taken. The increase in temperature was computed from the thermocouple-galvanometer readings, while the initial and final resistances of the solution were obtained from the resistance-temperature curves. The average resistance, $\bar{R}$, was used in the calculations. The runs lasted from two to twelve minutes. For a long run (ten or twelve minutes), the temperature of the solution was within one-half a degree above or below the temperature of the surroundings.

The rate of energy increase of the solution in watts was computed calorimetrically from the formula

$$\frac{\triangle H}{\triangle t} = 4.183\,K \qquad \frac{\triangle T}{\triangle t}$$

where "K" is the heat capacity of the solution and container, electrodes, etc., $\triangle T$ is the temperature increase in degrees, and $\triangle t$ the time of the run in seconds.

Diathermy currents of three different values were passed through each solution. In Table III are given the results for the 1,500-kilocycle diathermy machine, while the corresponding values for the 500-kilocycle machine are given in Table IV. With this latter machine two commercial ammeters were used, their currents being designated as "I_Z" and "I_V." All of these results were repeated, giving similar values.

It is seen from Table IV that the computed I^2R values agree to within 10 per cent with the calorimetric value of the rate of heat production for the 1,500-kilocycle machine. The agreement is even better with the 500-kilocycle machine, as Table III indicates. The tables further show that the diathermy ammeters, within experimental error, record the true heating current and hence any wattless component is small enough to be neglected in practice.

PART III.—FREQUENCY DISTRIBUTION IN DIATHERMY

In diathermy, alternating currents of frequencies from 500 to 3,000 kilocycles per second are produced by spark sets, while the frequency of the newer vacuum tube diathermy sets may go as high as 12,000 kilocycles per second, this latter type, however, as yet being in the experimental stage and not generally used clinically. A necessary condition which must be fulfilled by every diathermy machine is that the frequency must be great enough to prevent the sensation of electrical shock to the patient. For diathermy currents of frequencies higher than this limit, it is doubtful as yet whether there is any difference in the therapeutic value. Some physicians—and, in particular, salesmen of these machines—claim that there are such differences, but a thorough clinical study of the question is necessary. Yet before this problem can be investigated clinically it is necessary to understand the physical factors which control the frequency distribution in diathermy machines. It is the purpose of the following experiments to investigate in a qualitative manner the influence of the variation of the different physical factors on the energy distribution of the diathermy heating current.

Oscillating circuits which give out energy either through radiation of electromagnetic waves or through a resistance in the circuit do not oscillate at one given frequency, but the frequency of the current is distributed throughout a band. This is especially true

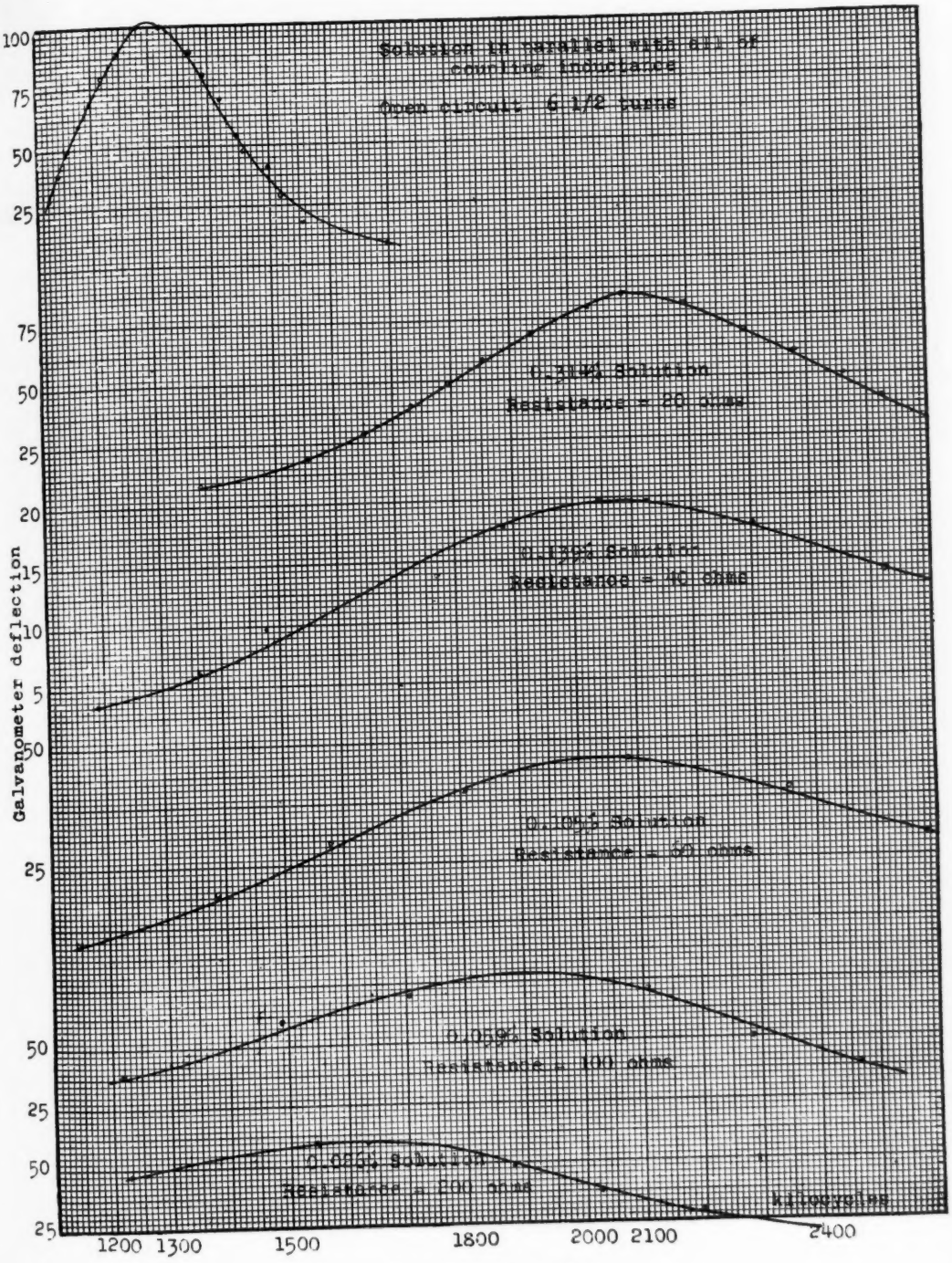


Chart 1. See page 114.

in diathermy machines where the patient is connected across a part or all of the inductance in the oscillating circuit. In the following experiments investigations will be made to determine the effect of different coupling combinations between the oscillating circuit and the external circuit containing the patient, and of the resistance of the patient on the frequency of the diathermy machine.

In studying the frequency distribution a General Radio Company precision wave meter was used, which consisted of inductance coils to be used with a precision variable air condenser, with a thermal galvanometer to indicate the current flowing in this tuned circuit. In some cases where the intensity of the radiated energy was sufficient the thermal galvanometer of the wave meter was used to indicate the current in the wave meter circuit. For low field intensities a vacuum tube voltmeter was used with the same wave meter, with the wave meter thermal ammeter short-circuited, to detect the current in the wave meter circuit. In taking measurements the wave meter was placed near the diathermy machine and the capacity varied in the usual manner, simultaneous readings of capacity and galvanometer current being taken. From calibration charts, the capacity readings were transposed to the corresponding frequencies.

The curves of the energy distributions are given in Charts 1-4. On the abscissa is plotted the frequency in kilocycles, while the galvanometer current of the wave meter is plotted on the ordinate.

On Chart 1 is given the energy distribution when electrolytic solutions whose high frequency resistances are comparable to those of the patients in diathermy are connected across the whole inductance coil of the oscillating circuit of the higher frequency diathermy machine or, according to Figure 4, $N_1 = N_2$. The distribution curve at the top of the chart gives the frequency of the open external circuit, with the peak of the curve at about 1,300 kilocycles. In this case the resistance in the external circuit is infinite. The resistances indicated on the curves give the approximate high frequency resistance of the electrolytic solution placed in parallel with the inductance coil of the oscillating circuit. These solutions were potassium chloride solutions whose corresponding concentrations are given under each curve. From the curves it is seen that with a low resistance, *e.g.*, 20 ohms, the peak of the distribution curve shifts from 1,300 kilocycles of the open external circuit (infinite resistance) to 2,100 kilocycles, and the band widens out, extending from 1,600 to 2,500 kilocycles. With higher resistances there is less shift of the peak but a greater widening of the band.

On Chart 2 are given frequency curves of a similar character to those on Chart 1. The same diathermy machine and the same solutions were used in the experiment and the same notation is used on the graph. In this case, however, the solutions between the electrodes of the calorimeter were connected across one-half of the total inductance coil in the oscillating circuit, or, as before, $N_1 = 2\,N_2$. It is seen that the shift of the peak from the open circuit (infinite external resistance) peak, as given in the curve at the top of the chart, is less than when the electrolytic resistance is shunted across the whole inductance coil of the oscillating circuit. The width of the bands from this second group of curves (Chart 2) is also less than those of the preceding page.

On Charts 3 and 4 are given representative curves from about fifty runs, which were taken with the lower frequency machine. By varying the inductance (N_1) of this machine, the peak of the open circuit frequency band could be shifted from 300 kilocycles to 620 kilocycles. This shift is indicated by the displacement of the wide distribution band of the circuit containing the

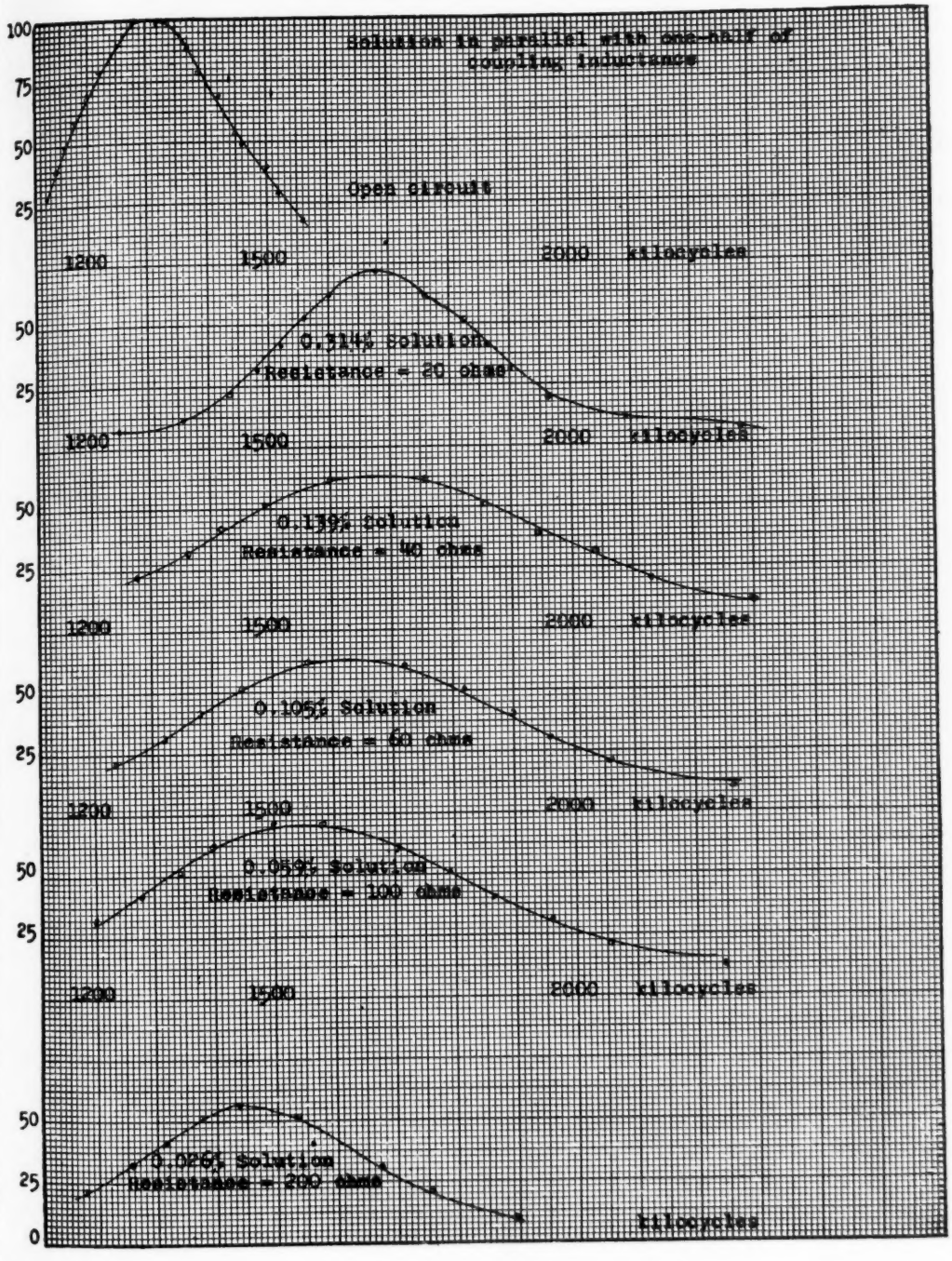


Chart 2. See page 114.

electrolytic resistance from the narrower band of the open external circuit. The inductance coil acting as the air-core autotransformer between the oscillating circuit and the external circuit containing the patient had 65 turns. N_1 gives the number of turns in the oscillating circuit (the autotransformer primary), while N_2 gives the number of turns of coupling inductance in the external secondary circuit (see Fig. 4). From the numbers N_1 and N_2 the relative amounts of inductance in each circuit can be estimated. Solutions were used with approximate high frequency electrolytic resistances of 20, 60, and 200 ohms. Sample curves are given for the 20- and 200-ohm solutions, and the coupling arrangements are given on each curve in terms of N_1 and N_2. On Chart 3 are given the distributions where a 200-ohm electrolytic solution is connected across one-half of the coil. The coupling inductance in the oscillating circuit is varied from a value about twice that of the external circuit ($N_1 = 65$) to a value a little larger than one-half that of the external coupling inductance, or $N_1 = 21$. In each case it is seen that the peak of the curve is fixed by the inductance of the oscillating circuit, while the relative amount of coupling inductance determines the width of the band. Thus the band is narrowest when N_1 is about twice N_2. The curves on Chart 4 are taken under the same conditions except that the electrolytic resistance is 20 ohms. The low resistance shunt causes a shift of the peak to higher frequencies, and the band is broadest and shift greatest when $N_1 = N_2$, or the solution is connected across all the inductance.

From these results and others not given here it may be concluded that the frequency of a diathermy machine is chiefly fixed by its capacity and inductance, but when the patient is connected across the whole inductance coil the frequency of the machine may change considerably, the deviation from the open circuit frequency (dependent on the capacity and inductance) depending on the magnitude of the resistance of the patient. Since the deviation is towards higher frequencies there would be little possibility of electrical shock to the patient, but with the deviation of the peak there is also a widening of the band dependent also on the resistance, being wider the lower the resistance; but it is doubtful whether the energy of the lower frequencies of this wide band would extend to the lower injurious frequencies. A study of these curves will also show that if it is desired to have the diathermy machine operating at an approximately constant frequency and over a narrow range, it would be advisable to have the solution or patient connected across one-half of the inductance of the oscillating circuit, or, according to Figure 4,

$$N_1 = 2\,N_2.$$

The coupling inductance in the external circuit, namely, N_2, might be less than this, giving a still narrower band, but, if so, there would be more radiated energy, and, hence, greater loss in the machine, with decreased efficiency.

PART IV.—MEASUREMENT OF THE HEAT ENERGY GIVEN TO THE PATIENT IN DIATHERMY

As mentioned earlier in this paper, a knowledge of the true heating current, which has been shown here to be given by the diathermy ammeter, would not indicate the heat energy imparted to the patient. The ammeter merely serves as a means of preventing burning of the skin at the electrodes by keeping the current density below a certain limit. With alternating currents the instrument used to measure energy is the wattmeter, an instrument capable of measuring energy independent of the phase angle. But, due to the high frequencies, a wattmeter cannot be used in the external

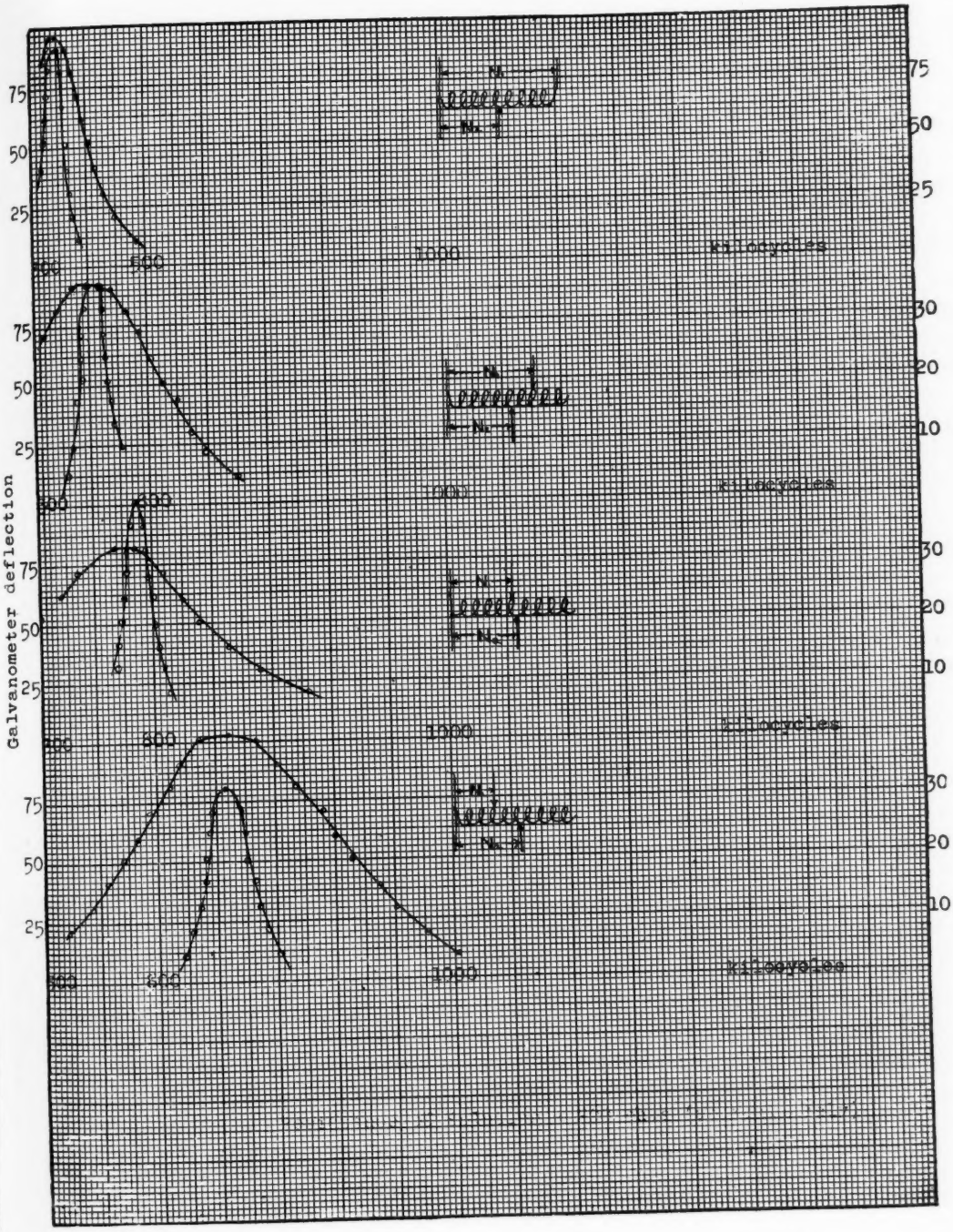


Chart 3. See page 114. Resistance of solution=200 ohms (approximately).

circuit which contains the patient, as wattmeters are built on the electrodynamometer principle and can be used only for low frequencies. A wattmeter, however, could be placed in the primary circuit of the 60-cycle transformer, as indicated in Figure 4. This would measure the total power used by the machine and might give an indication of the heat energy imparted to the patient. This method has been suggested by D'Arsonval (1927), but, as yet, the possibility of such a scheme has not been investigated. In the following experiments a wattmeter has been used in the primary circuit and the wattmeter readings compared with the power output to the solution to determine if the wattmeter readings would give an indication of the heat energy imparted to the patient.

For these experiments the lower frequency (500-kilocycle) machine was used and the measurements were taken simultaneously with those described in Part II. The coupling inductance of the external circuit to that of the oscillating circuit was kept constant, and the spark gaps were kept at a total width of one millimeter, each gap being 0.25 millimeter. The current through any solution was adjusted by varying the resistance in the primary circuit of the 60-cycle transformer. The solutions used for the experiments were those to which reference has already been made, and had high frequency resistance of from 20 to 200 ohms. The results are given in Table IV, and are plotted in the curve of Chart 5. In this curve the power input as read from the wattmeter is plotted on the abscissa, while the power output to the patient is plotted on the ordinate. It is seen that an approximate linear relation exists for lower power values. The resistances of the solutions are indicated by special points on the curve, and the greatest deviation occurs for high resistances and with large currents. Roughly, for points on the straight line it may be said that the power given to the patient in watts is 50 per cent of the wattmeter reading. This curve, then, shows that the wattmeter does indicate the heat given to the patient for lower resistances, such as occur in diathermy.

The total energy input may be distributed in three different ways, namely: (1) energy loss at the spark gaps, (2) radiation and high frequency losses in the machine, and (3) energy given to the patient. It has just been shown that when the spark gaps are kept constant at a total gap of 1 millimeter and the coupling inductance is kept fixed in the machine used for these measurements, 50 per cent of the input energy is lost as energy loss in (1) and (2), while the remaining 50 per cent of the input energy is imparted to the solution. When higher resistances are shunted across one-half of the inductance the impedance of the resistance branch will increase, while that of the impedance branch will remain the same. Consequently more current will flow through the inductance, increasing the radiated energy, and hence the energy loss in (2), as wave meter intensity readings will indicate. This may account for the deviations from linearity of the curve for the higher resistances. However, in diathermy usually the resistances are 60 ohms or less, as the measurements of Part II have shown, and hence in clinical practice the deviation from linearity will be a rare occurrence.

In practice, however, the spark gaps are not fixed but are varied to adjust the current flowing through the patient. Since there is energy loss at the spark gaps, it is to be expected that the amount of energy loss will change when the gaps are varied. This would then change the efficiency of the machine, which was, in these experiments, about 50 per cent. If the efficiency remains constant, the energy given to the patient will be then one-half of that recorded on the wattmeter. Experiments were

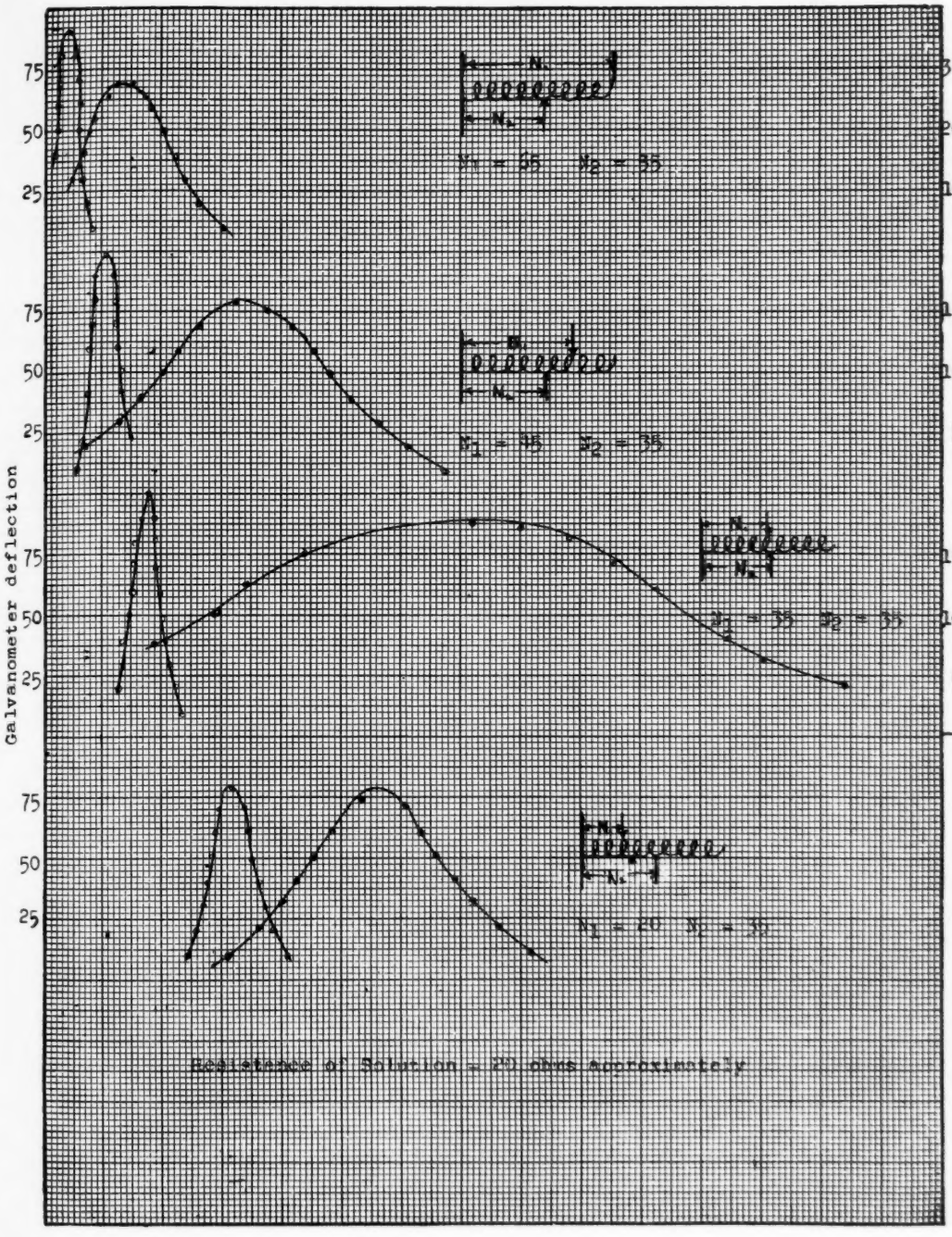


Chart 4. See page 114.

then made to determine in what manner the efficiency varied with the spark gap, using, as before, the different solutions whose high frequency resistances covered the range of high frequency resistances of the patients in diathermy.

In the procedure the current passing through a given solution was kept constant, as determined by the ammeter readings. Since it has been shown that this current to within a small error is the true heating current, then it may be assumed that for a constant heating current the energy output is constant. The spark gaps were then varied and the wattmeter readings recorded. The gaps were measured with a thickness gauge and cleaned after every five measurements. In the curves on Chart 6 are given the results of these measurements. On the abscissa is plotted the total spark gap, while on the ordinate are given the corresponding wattmeter readings. The coupling inductance remained unchanged. The currents and electrolytic resistances are indicated for each curve.

These curves in reality give a measure of the efficiency. Since the power output to the solution was constant and the wattmeter readings W gave the input energy, the efficiency could be defined as

$$\text{Efficiency} = \frac{\text{Energy output to solution}}{\text{Total energy input}} = \frac{K\ (\text{a constant})}{W}$$

Thus, the larger the values of W the smaller the efficiency.

These curves show that the efficiency is greatest and approximately constant for values of the spark gap between 1 and 2 millimeters. Beyond this region the efficiency changes with the gap. The measurements from which the curve of Chart 5 was drawn were for a spark gap of 1 millimeter, which is at one end of this range. The deviation observed in this curve for the high resistance solutions with high currents may also be explained by the lowered efficiency of the machine with the gap of 1 millimeter.

These results are given for one diathermy machine only. The same principle should apply to any machine, but, no doubt, with different machines different values of efficiency and of constant maximum efficiency for the spark gap variation would be obtained. The only sure method in practice would be a calibration of each machine.

DISCUSSION OF RESULTS

The results show that the heat produced in solutions whose high frequency resistances are of the same order of magnitude as those of the human body in diathermy, within experimental error, is equal to the computed value of the heat produced using Joule's I^2R relation. Hence, the current as registered by the diathermy ammeter in series with the patient does indicate the true heating current, and any wattless component of the total current is small enough to be within the limits of experimental error. The largest error in these measurements occurred in the ammeter readings, which were in many cases unsteady, due to fluctuations in the spark gaps. The probable error in the ammeter readings would be doubled when used in the I^2R calculation. The commercial ammeters indicate the true heating current, giving in many cases better calorimetric values of the heat energy in the I^2R relation than this quantity computed with the equivalent direct current of the vacuum thermocouple.

If the low frequency resistances of the solutions, as determined by the Kohlrausch method, were used in the I^2R relation, a large discrepancy would result between the computed values of the heat energy and the calorimetric values. This illustrates the importance of taking the resistance measurements at high frequency.

The conclusions of these experiments are contrary to those of d'Arsonval (1927) and the calculations of Fabry (1927). It has been shown, however, that d'Arsonval uses solutions with too high resistances and that

Chart 5. See page 118.

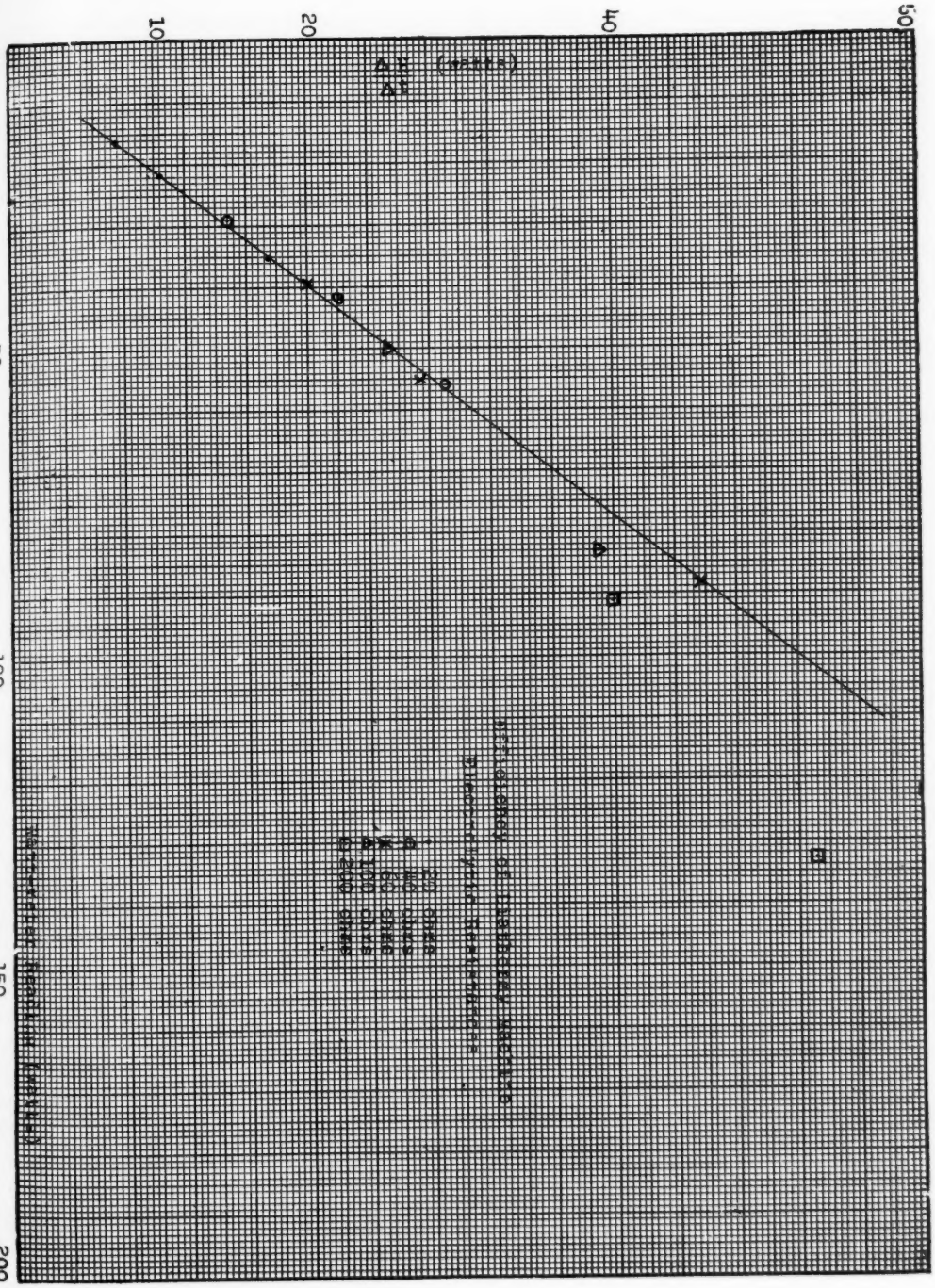


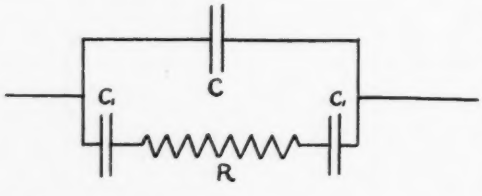
Chart 5. See page 118.

Fabry treats an electrolytic cell as a condenser shunted with a resistance—an assumption not valid at high frequency and with fairly concentrated solutions. However, d'Arsonval's results with Fabry's calculations may represent the limiting case for extremely high resistances by the following considerations:

If two platinum electrodes of equal area A, similar to those used by d'Arsonval, were placed in a beaker of distilled water of di-electric constant K, the capacity of the system except for end-effects would be given by the usual parallel plate formula used by Fabry.

$$C=\frac{4\pi A}{d}K,$$

where d is the distance between the plates. Now, however, suppose a few milligrams of NaCl were introduced into the beaker. These would immediately dissolve and ionize and on passing an electric current through such a solution Helmholtz double layers would be formed at the electrodes, while the interior of the solution would have increased conductance. Hence, superimposed on the parallel plate capacity, as given by the above formula, would be this double layer capacity at each electrode with the low connecting resistance. Such an electrical system could be represented thus—



where C_1 would represent the double layer capacity at each electrode, R the low resistance of the interior of the solution, while C would represent the electrostatic capacity of the system with water only between the electrodes. The leak resistance across the double layer is not represented, as it has a negligible effect at high frequency. Calculations and experimental values will show (see McClendon, 23, 24, 25) that the capacity C is very small, while C_1 is very large and R is small. Hence the relative impedance of the lower branch is much less than the relative impedance of the upper branch, whence the impedance of the lower branch fixes the current. Of this impedance at high frequency the effective part is the resistance R. But when the resistance R becomes large and the capacity C_1 small, due to decrease in the concentration of the electrolyte which occurs at high dilution, then the impedance of the lower branch becomes large in comparison with the impedance of the upper branch, and in this case it is the capacity C which determines and is responsible for the large wattless component of d'Arsonval and Fabry. But in diathermy practice the electrodes are usually so very far apart that the electrostatic capacity C is negligible, while R is small; hence the impedance of the upper branch is large and may be neglected. In the experiments recorded here the electrodes were 5 cms. apart and much closer than in actual diathermy practice, the reason for this proximity being the limited dimensions of the calorimeter. The deviation noted for a frequency of 1,500 kilocycles, and especially that of the 200-ohm solution, may be due to the relative increase of the wattless component of the current, due, in turn, to the impedance of the lower branch of the above diagram becoming in magnitude of the order of the impedance in the upper branch. This would tend to give an effective current greater than the true heating current. But, as already mentioned, the electrodes in diathermy are widely separated, and if the deviation as observed was due to this effect in the solution in practice it would be negligible.

Chart 6. See page 120

SUMMARY

1. The high frequency resistance of the human body, using diathermy electrodes

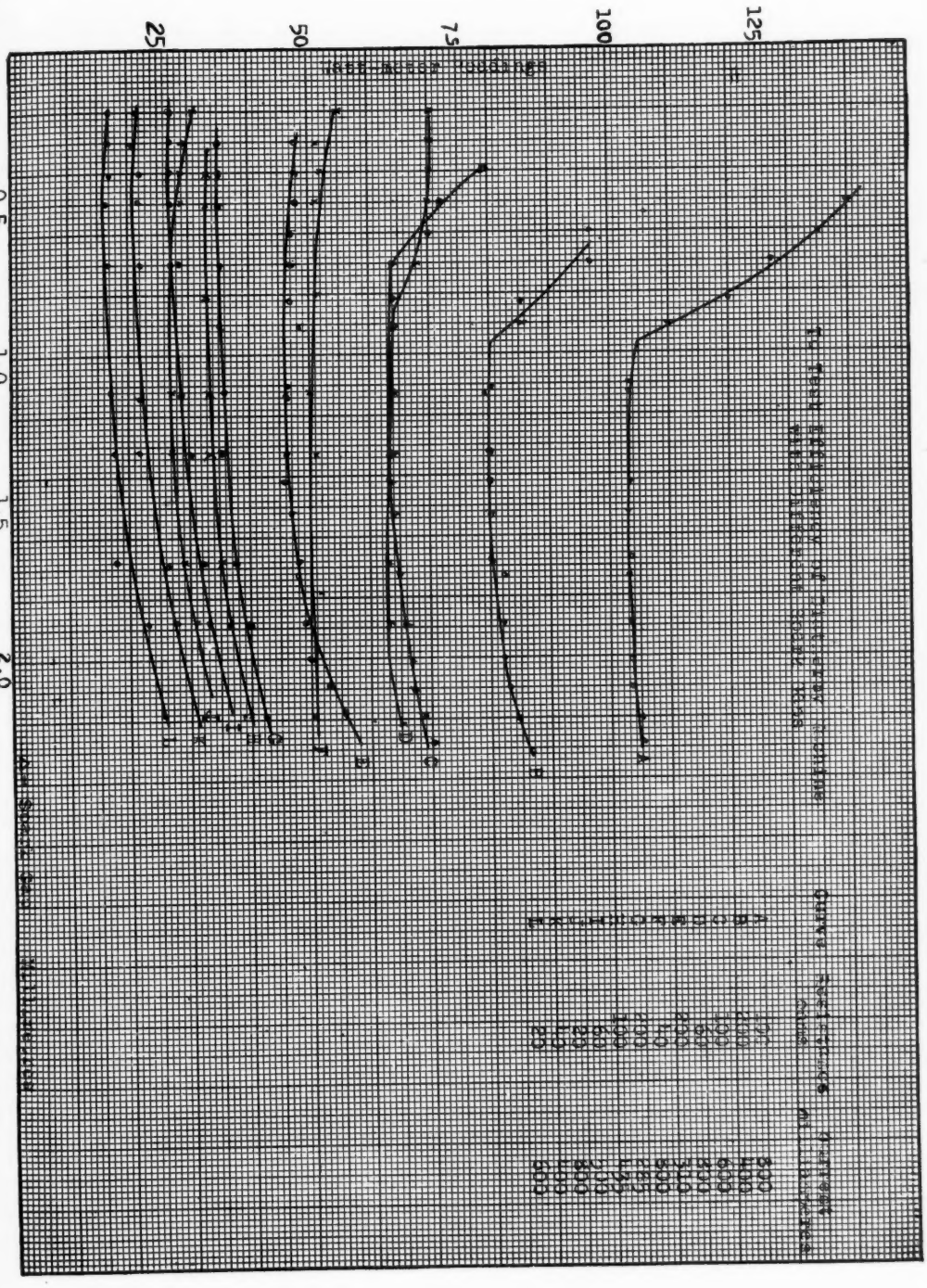


Chart 6. See page 120

placed at different parts of the body where diathermy treatment is given, has been measured, using a high frequency bridge with a heterodyne method of detection. The high frequency resistance has been found to vary from 20 to 200 ohms, with a low resistance, 20 to 40 ohms, through the body, and with higher resistances, 60 to 200 ohms, for the limbs and joints.

2. From consideration of the theories of Gildemeister, Banerji, McClendon and others, it is shown that a solution can be substituted for a patient in diathermy for calorimetric experiments only when the high frequency resistance of both the patient and solution are used.

3. Quantitative measurements of the heat produced in a solution were made, using a 500- and 1,500-kilocycle diathermy machine and solutions whose high frequency resistances covered the diathermy range. With the 500-kilocycle machine the heat given to the solution by the diathermy current agreed within experimental error with I^2R value. With the 1,500-kilocycle machine the I^2R values were in some cases 5 to 10 per cent higher than the calorimetric value of the heating effect. The deviation from the I^2R value is probably due to electrostatic capacity of the solutions, which, in diathermy, would be negligible.

4. Using ammeters from the Victor and Kelley-Koett diathermy machines, the experiments show that these register the true current as well as it can be measured due to spark gap fluctuations, as determined calorimetrically and from comparison with a vacuum thermocouple-microammeter current-measuring device.

5. From a study of the frequency distribution curves, it is seen that the effect of the electrolytic resistance shunted across part of the inductance coil is to cause a displacement of the frequency band from that of the free oscillating circuit toward higher frequencies, the greater displacement occurring for the lower electrolytic resistance. The smaller the fractional part of the total inductance coil in the oscillating circuit forming the shunt for the electrolytic resistance, the narrower is the frequency band. Hence, to have the diathermy machine operating on a narrow band of frequencies shunting the solution across one-half of the total oscillating inductance coil is recommended.

6. In order to measure the total energy and efficiency, a wattmeter in the primary circuit of the transformer, as suggested by d'Arsonval, has been used, and for a 500-kilocycle machine with total spark gaps between 1 and 2 mm., the heat produced in the solution by the diathermy current is directly proportional to the wattmeter readings. (The ammeter indicates the heat and temperature at the hottest part.) Since the resistance values in diathermy vary from 20 to 200 ohms, the heating effect as measured by a suitably calibrated primary wattmeter would be a much better indicator of the heat produced in the patient than a high frequency ammeter in series with the patient.

Acknowledgment.—In concluding, I wish to thank Dr. K. W. Stenstrom, who suggested this problem, for his timely advice, and his inspiring interest in this work.

I also wish to thank Dr. J. F. McClendon, of the Department of Physiological Chemistry, for the use of the laboratory with its apparatus where much of the work was done.

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GRENZ-RAY THERAPY[1]

By GUSTAV BUCKY, M.D., NEW YORK

OUR assumptions of biological ray effects in general have led to the establishment of certain rules. The biological action of different wave lengths has been studied through the morphology of the cell, which means that a histological picture has been supposed to give an understanding of the biological reaction. Morphological changes, however, are end-results of disturbed functions, though these latter are not necessarily followed by such morphological changes: there is a limitation to these investigations.

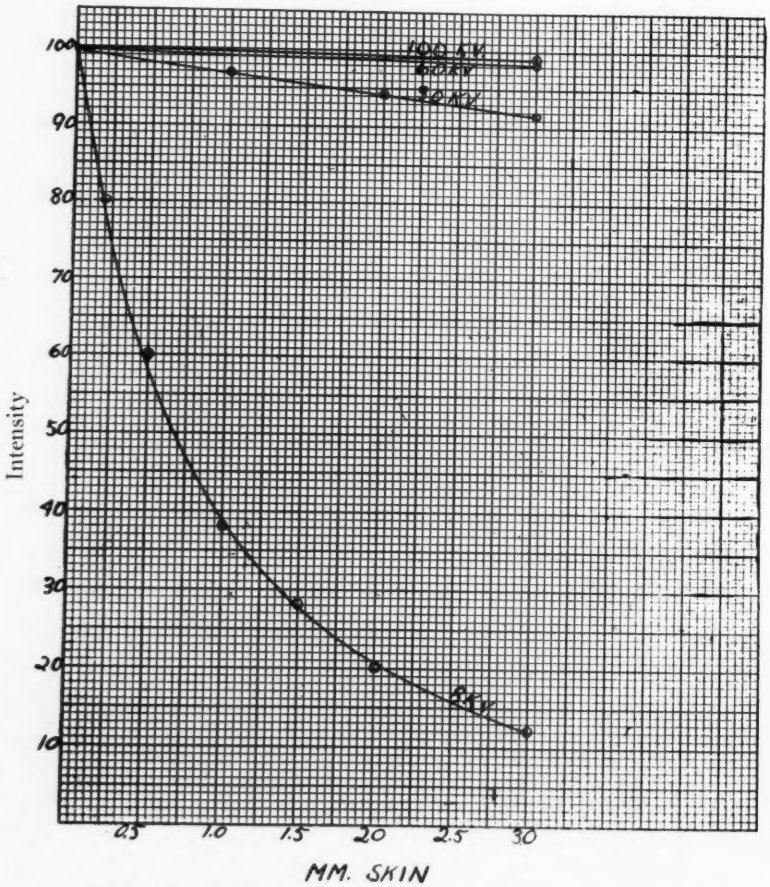

Fig. 1. Comparison of absorption in skin of X-rays and Grenz rays.

Following along these lines, experiments were conducted on eggs, especially of *Ascaris* and fruit flies, since the egg, offering a basic structure in a primitive stage—so to speak, a histologic unit—is simpler for experi-

[1]Read by invitation before the Radiological Society of North America at the Fourteenth Annual Meeting, at Chicago, Dec. 3–7, 1928.

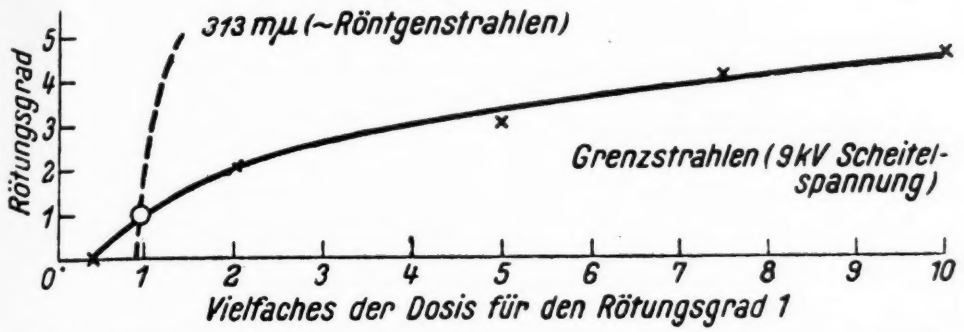

Fig. 2. Curve showing the increase of the degree of redness of the skin erythema with increasing dosages after radiation with Grenz rays in comparison with roentgen rays. (Translation of descriptive words: Rötungsgrad, degree of erythema; Röntgenstrahlen, roentgen rays; Grenzstrahlen, Grenz rays; Scheitelspannung, maximum; Vielfaches der Dosis für den Rötungsgrad 1, Multiple of the dosage necessary for erythema degree 1.) *After Hausser and Schlechter.*

mental purposes than complicated adult tissue.

It is not my intention to offer criticism, so far as the ordinary roentgen-ray range is used: what I wish to point out is that the range of electromagnetic oscillations of about 2 Ångstrom units makes it necessary to analyze biological experiments from another standpoint, considering some fundamentally different properties of these oscillations. There cannot be any doubt—and I have emphasized it again and again—that the wave lengths in question are roentgen rays from a physical point of view, so far as a general classification is possible.

However, physical properties must be viewed differently than biological actions. Nevertheless, should not the above-mentioned experiments on eggs be conclusive for the difference or the similarity of the biological action of the commonly used X-ray and the range I have called the Grenz ray?

It should not be difficult to answer this question. Upon glancing at Figure 1 you will observe from a study of these theoretical curves that rays produced with a tension

Fig. 3. Skin of rat, 21 days after roentgen radiation, showing newly formed, dilated, subepithelial capillaries.

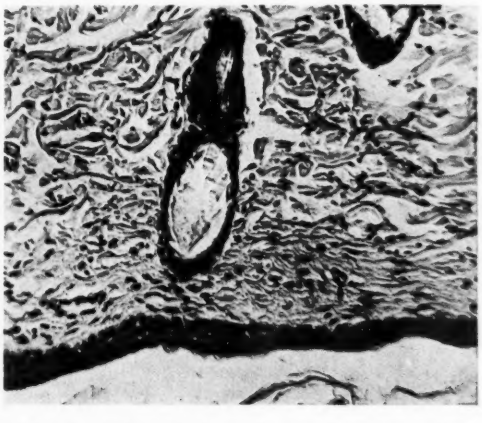

Fig. 4. Skin of rat, 21 days after Grenz radiation, showing small empty capillaries and cellular hyperplasia in the subepithelial layer.

of 100 K.V. are absorbed only to such an extent that the original intensity of the rays is diminished one-quarter of 1 per cent by 3 mm. of skin. This means that tissues beneath the skin will be affected by almost the same energy as the skin itself. If you now look at the curve described by a tension of 8 K.V., you will notice a fundamental difference of the distribution of absorption. Here we find at a depth of 3 mm. only 12 per cent of the incident intensity. If we direct our attention to the different layers of the skin—which certainly have different duties, or, at least, differ in age—it will be obvious that the distribution of absorption as shown in the curves must result in different biological influences, and thus different biological symptoms or effects may depend—at least, to a great extent—on the distribution of absorption. Whether or not there is a specific wave length effect cannot be stated at present. However, from these simple considerations one can see that the rule of the similar biological action of different wave lengths cannot be generally applied to the range in question. Experiments on minute eggs must, therefore, lead to conclusions which cannot be applied to effects

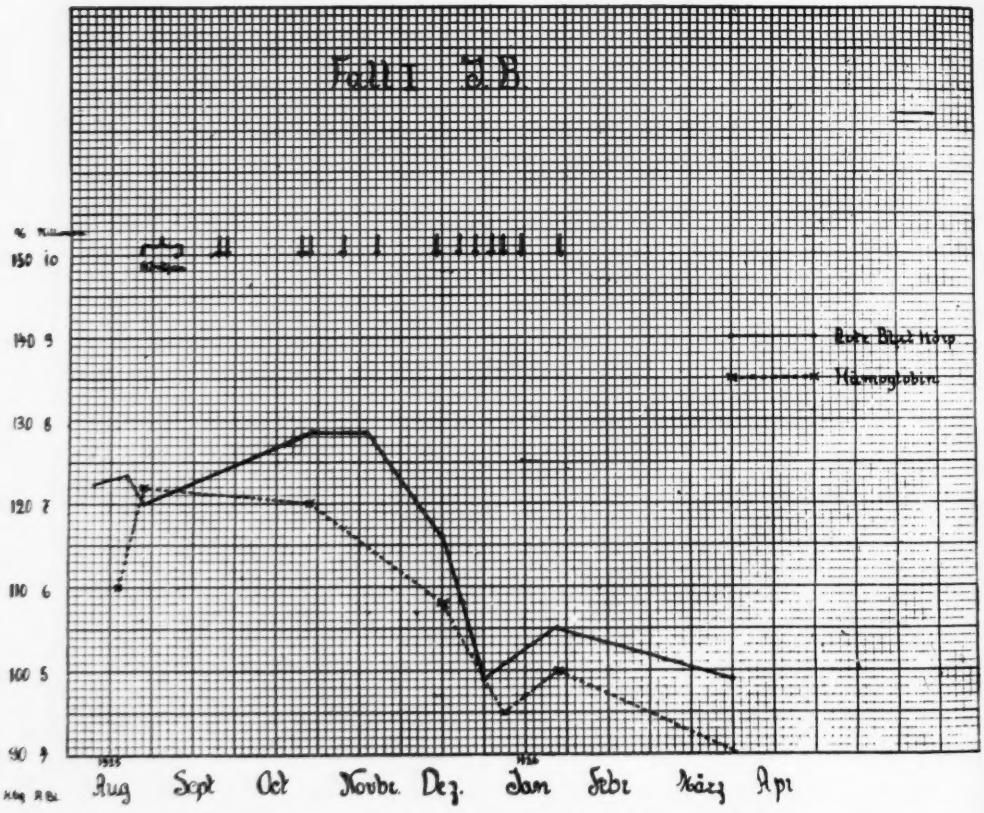

Fig. 5. Chart of Case 1. The patient could not be induced to come regularly for treatment, consequently no regular series could be given and the treatment was neglected. The roentgen-ray treatment during August and September was followed by an increase of red blood corpuscles, the climax being reached in November. In September the patient received only two Grenz-ray treatments. From the end of October the patient came somewhat more regularly for treatment. The arrows indicate only the time of the treatments, but do not represent single sessions.

on complicated tissues if long wave lengths are used.

Furthermore, for the biologist the biological changes stand in the foreground and the mechanism of the action is of secondary interest. This means that we shall be justified in distinguishing ray ranges in regard to their biological effects rather than their wave lengths. Such justification becomes a necessity if the *name* tends to cause mistakes or erroneous analogies.

The difference between the clinical reactions produced by roentgen and Grenz rays is obvious: for instance, one has only to glance at Figure 2, which demonstrates the difference between erythemas. Histologic studies in collaboration with Dr. Goldzieher, pathologist, and Dr. W. Highman, skin histologist, have revealed the marked differences shown in Figures 3 and 4, changes which were produced with practically the same incident energy. It will be readily understood that such intrinsic physical properties as shown by the absorption curve in this range necessitate a minute technic based upon a fundamental knowledge of the physical factors as well as of modern measurement methods. I hope Dr. Glasser, my former collaborator, will explain the important physical features.

The limited time at my disposal allows me only a few remarks as to clinical observations. One of the outstanding features of Grenz-ray therapy is the absence of danger *if proper technic is applied.* I emphasize the second part of this sentence as former publications of mine have been misunderstood by several authors. In speaking of the danger of a method we should be aware of the general rule that if there is action

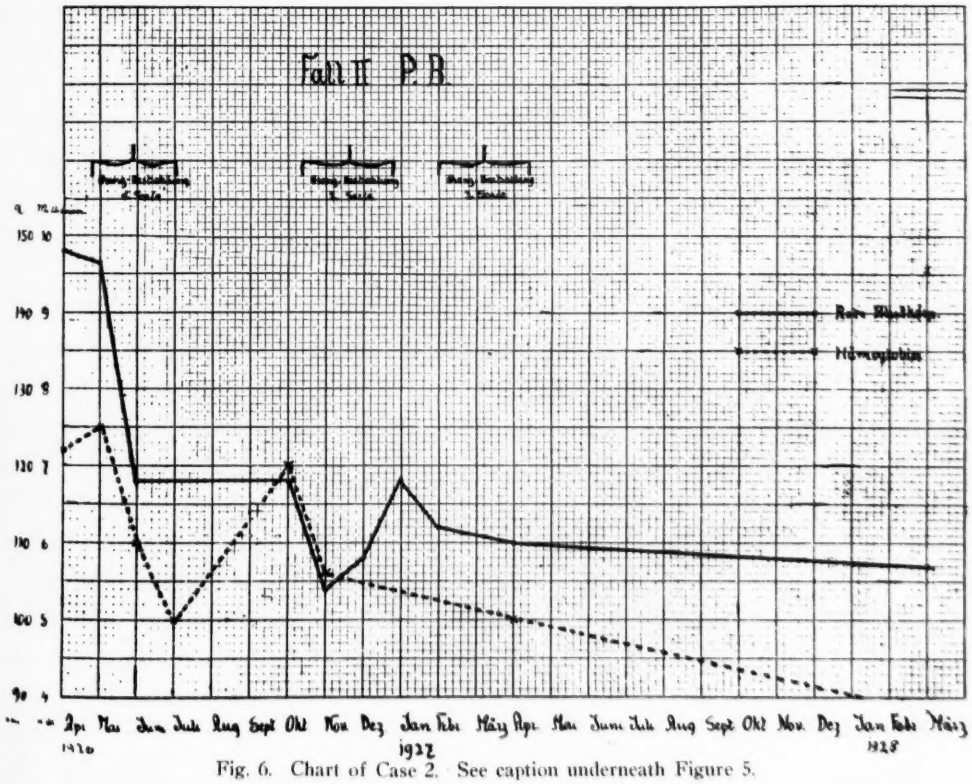

Fig. 6. Chart of Case 2. See caption underneath Figure 5.

there must be an attendant danger, otherwise no effect can be produced. An overdosage of a harmless drug can act like a poison. The harmlessness of a method can be judged only by distinction between therapeutic dosage and injurious dosage: such distinction is rather marked in the case of Grenz rays. However, if one desires experimentally to cause injury, he can do so by applying dosages in excess of therapeutic needs. So far as the danger of possible injury is concerned, there is no comparison between that produced by roentgen and Grenz rays: no real roentgen ulcer can be produced with Grenz rays. The resulting ulcerations are superficial, practically painless, and have a distinct tendency to heal within a short time. Sequelæ of such experimental overdoses consist of slight atrophy and telangiectasis only, but even these may later on disappear spontaneously, as described in my book, "Grenz-ray Therapy."

If proper technic is applied, Grenz-ray therapy in dermatology excels roentgen-ray therapy. A brief quotation from a paper by Dr. Spiethoff,[2] Professor of Dermatology at the University in Jena, may serve to illustrate this assertion. Dr. Spiethoff writes:

"During two and a half years of practical experience with Bucky's soft rays we have solved the problem of technic and indications to such an extent that intrinsic changes are not to be expected, and publication of our experience is justified. In our clinic Bucky's soft rays have replaced roentgen rays in all those cases where we have to deal with the so-called

2München. med. Wchnschr., Nov. 16, 1928, No. 46.

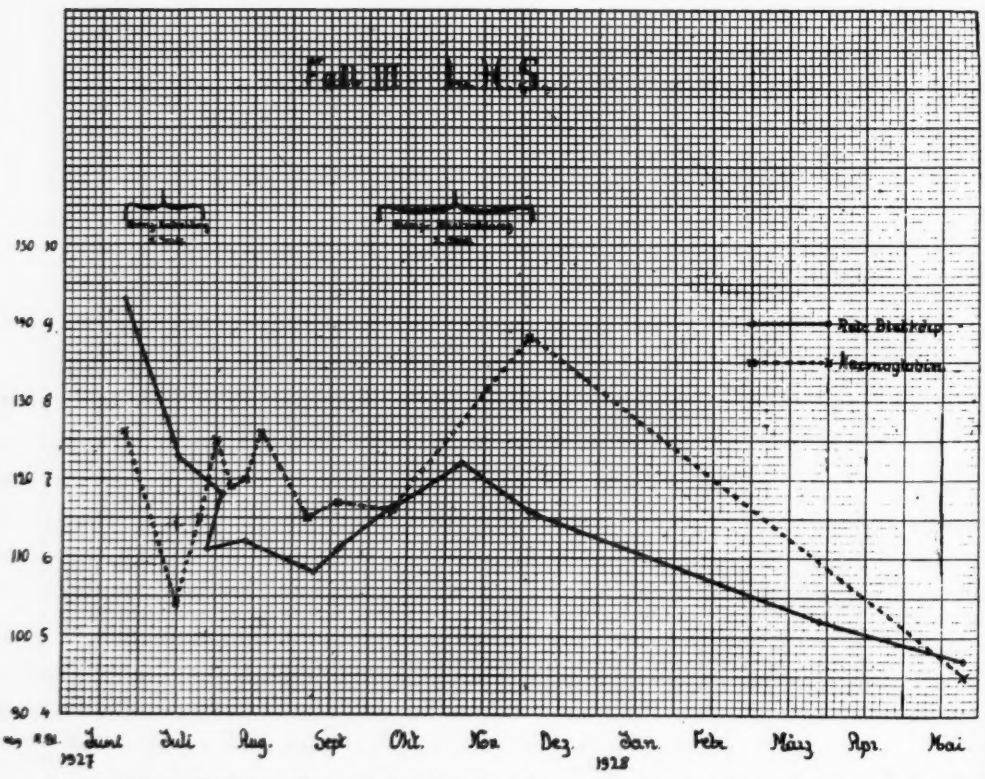

Fig. 7. Chart of Case 3. The second series of treatments was drawn out over a longer period than the first, because the patient came irregularly.

'local superficial therapy,' and besides have gained several indications which were confined to deep therapy. Furthermore, these rays have opened new fields which were inaccessible to roentgen rays because of the prospective danger of the latter. In my opinion, the absence of danger—which can be safely stated from a practical point of view—cannot be sufficiently appreciated. It is the main advantage of Bucky's soft rays, besides the above-mentioned extension to new fields, because it makes it possible to continue irradiation as long as therapeutically necessary or to repeat irradiation as soon as circumstances may require. We are not compelled to interrupt radiation so frequently as with roentgen rays, after a fixed dose, because of imminent danger, sometimes at the very instant that further radiation is essential for a desired result."

I cannot better summarize my own experience in dermatologic cases. However, Spiethoff emphasizes that proper technic is essential. Summarizing the latest publications and my personal impressions, gathered in European clinics this year, I can state that differences of opinion in regard to the value of the method are due only to the technic used. In dealing with a new therapeutic method it is impossible to form a final conclusion after only a few months' experience. So far as former attempts by Frank Schulz, Stern and others to use soft X-rays are concerned, I do not wish to go into details, and refer you again to my book, an English edition of which has been published.[3] One fact, however, must be stated, namely, that all former experimenters have used much harder rays—that is, shorter wave lengths—and have, therefore, seen undesirable after-effects. Certainly the sequelæ might have been partly due to insufficient knowledge of dosimetry; nevertheless, the roentgenologic world unanimously assumed roentgen rays of long wave lengths to be dangerous, and in their effect inferior to harder roentgen rays. It is not possible to explain here how I arrived at the incorrectness of this assumption, and I must, therefore, refer you again to my book. The same holds true with other mistakes made by different authors: only a lack of time prevents me from discussing them.

[3]By Macmillan Company.

If the advantages of Grenz-ray therapy lay only in the field of dermatology, roentgenologists would be interested in the method to but a limited extent, but, as emphasized in my first publication on the subject, the chief value of the method is to be found in internal diseases and in physiologic determinations. For instance, the drop in leukocyte count after the administration of Grenz-ray therapy is characteristic. Several authors have assumed that a like drop can be produced by roentgen-ray therapy, but the incorrectness of this assumption has been proven by my former assistant, Dr. Manheimer. There is no doubt but that the leukocyte drop produced by Grenz rays is caused by skin irritation, whereas roentgen rays act on the vessels mainly. The underlying cause of the consequent drop in the leukocyte count was well understood before the question of the action of different rays arose. We maintain that the leukocyte drop produced by Grenz rays must be considered as the effect of an irritation of the autonomic end organs in the skin, an assumption which fits in very well with that of Petersen, of Chicago. Again, I can only mention, not discuss, these subjects.

However, such observations formed the basis for further investigations concerning the influence of this therapy on diseases probably due to disturbances of the autonomic nerve system, such, for instance, as ulcerations of the stomach and duodenum, and polycythemia. The effect in these diseases was highly satisfactory. I wish to show you a few curves of polycythemia cases (Figs. 5, 6, and 7).

Other conditions reacting favorably—and sometimes to a surprising extent—to Grenz-ray therapy are endocrine disturbances and certain types of arthritis. The effect on the general condition of the patient is remarkable, especially in cases of general asthenia.

His efficiency increases, he has a zest for living, and in the case of older individuals there is almost a rejuvenating effect. Oligomenorrhea and amenorrhea should be mentioned in this connection because these conditions are indications for deep therapy which can be classified as well or even better under indications for Grenz-ray therapy. By this I mean that in certain diseases in which we have attempted to create depth effects we are probably dealing with a skin reaction mainly. This point would seem to be of especial interest to the radiotherapist, who, we can imagine, will have occasion to revise his previous assumptions if polycythemia, for instance, can be influenced by these easily absorbed rays. Evidently it is not necessary that irradiation penetrate to the bone marrow. As Spiethoff has stated elsewhere than in the paper cited above, a number of deep therapy indications may be usurped by Grenz-ray therapy in the future.

DISCUSSION

Dr. Rollin H. Stevens (Detroit): I regret very much that I had not seen this paper before the time to discuss it, and I do not feel competent to enter into a discussion of the treatment of some of the diseases that have been mentioned by Dr. Bucky. Certainly the results which he has shown here are very remarkable. We have been using the Grenz ray, so-called, for a little over a year and a half, but have confined ourselves to the treatment of superficial skin lesions, mostly of a mycotic nature, and have found, we think, that the results from this treatment are rather superior to those from the ordinary higher voltage X-ray. We recently read a paper, which perhaps most of you have seen, by Rothmann of Göttingen, in which he described the histological changes taking place at various times after radiation with the Grenz ray, at 9 K.W. He described its characteristic action as being upon the stratum granulosum of the skin. It produced a swelling and ballooning of the granular cells, while the basal-cell and prickle-cell layers were very little affected. Later on, in the advanced stages (that is, somewhere from twenty-four days to three months later), the latter show some changes. Changes are also seen in the papillary layer of the cutis, consisting of dilatation of the blood vessels and the presence of some lymphocytes around the vessels. We think that these changes in the granular layer are the most interesting, because they probably explain some of the effects observed in long wave X-ray treatment of superficial skin lesions that we may not find after treatment with the X-ray of higher voltage. The rays of long wave length are probably stopped in the granular layer, setting up secondary rays which react further upon the granular layer, causing the changes observed. This may be the reason for the good results seen in ringworm and other superficial skin conditions. If we get such results as Dr. Bucky has stated follow in some general diseases like polycythemia, the anemias, etc., it must be from the absorption of a small amount of protein matter broken down under the action of the rays. Whether this would be of sufficient amount to cause a general reaction that could affect a disease like polycythemia or not, I do not know. However, recently, my associate, Dr. Jarre, in consultation on a case of agranulocytic angina, suggested the injection of a small quantity of protein matter to stir up the white blood corpuscles, which at that time were down to nine hundred. The patient was in a very weakened state and seemed to be a hopeless case. The injection of a tenth of a cubic centimeter of typhoid vaccine brought the corpuscles up to almost normal within from twenty-four to forty-eight hours. That was a small amount of foreign protein to accomplish so much. Possibly the absorption of the small amount of protein toxin that these rays would pro-

duce in destroying the cells in the granular layer of the skin might have some similar action.

The paper by Dr. Bucky certainly is very interesting. I would like to inquire about how much of the body surface he has radiated in order to produce these general results. It would seem as though radiating a small area would hardly be sufficient to produce such general reaction as the Doctor has described.

DR. OTTO GLASSER (Cleveland): I should like to say a few words in regard to the physical measurement of the dosage when these soft roentgen rays, or Grenz rays of Dr. Bucky, are used. When, at the suggestion of Dr. Bucky, we started to work on this problem about four years ago, we realized at once that an exact dosage was necessary when Grenz rays are used, since the output of different tubes, different apparatus, etc., even under identical experimental conditions, varied as much as several hundred per cent. To start with, we went back to the more familiar standardization methods of roentgen-ray therapy and altered them somewhat in order to use them for Grenz rays. We first determined Grenz-ray doses in r-units by means of an open air ionization chamber. Then we measured their quality by taking absorption curves in thin aluminum foil. By calculation we obtained curves which enabled us to read the transmission of these soft rays through water and also through the different parts of the human skin. We then went farther and constructed a small ionization chamber of extremely thin goldbeater's skin, which can be used in connection with ordinary roentgen dosimeters and permits the radiologist to carry out his own dosage measurements in the practical use of the Grenz rays. We thus put Grenz-ray dosimetry on a sound physical basis, at the same time furnishing practical instruments which can be used easily. Such a sound physical basis for the use of Grenz rays seems to be absolutely essential if we are to obtain satisfactory results, and if we are to be able to compare these results with those obtained elsewhere.

DR. H. J. ULLMANN (Santa Barbara, Calif.): I have never used the Grenz ray. I hope to try it, but there is something to be considered when attempting to interpret some of the results, so far as general effect on the body is concerned. Several years ago, some English workers demonstrated that if a certain percentage of the total skin area of the body was irradiated with ultraviolet to the point of producing an erythema, immunity reactions were increased, while if a larger area was treated they were decreased. Later it was found that an erythema produced by infra-red would do the same thing; and still later, by chemical irritants, such as mustard plasters, so that there must be a definite reaction of the body as a whole to any irritation of the skin. One might interpret some of these results in that light.

DR. M. J. SITTENFIELD (New York): About ten years ago I was very much interested in the biological effect of the photodynamic substances. Chemical substances like eosin, Bengal red, hematoporphyrin, etc., are photodynamic. I believe I described some of the experiments before this Society about six or seven years ago. These substances become photodynamic in the presence of bright sunlight to such an extent that they kill small laboratory animals in from thirty to sixty minutes. At that time we used normal animals as controls to those which had been injected with hematoporphyrin, and to our surprise we found that about 20 per cent of the normal animals succumbed to the waves of ordinary sunlight. The external mucous membranes became edematous, the skin hyperemic, the

animals began to scratch and itch, and finally developed dyspnea, paralysis of the lower extremities, and died in convulsions. We are dealing here with the effects of the sun ray upon the skin, and perhaps an absorption of substances from the skin, which induces hemolysis of the blood. There was a drop in the hemoglobin, the red blood cells were greatly diminished, and with this, the white cells went to pieces. I would like to ask whether there is not some relationship between the effect of the rays of the sun, with the injury to the skin, and that of the Grenz rays?

Dr. W. Stenstrom (Minneapolis): We have started to study the effect of cathode rays upon the leukocytes. Dr. Watkins, a hemotologist, is responsible for the blood study. We expected to find something similar to what Dr. Bucky has described, that the white count would go down rapidly after the radiation and slowly come back. I would like to ask Dr. Bucky if he will give us a little more information about how those measurements were made—were they made on animals or on human beings? We studied the effect on rabbits, and we radiated just a small area—2 by 2 or 3 by 3 centimeters. We found that we had a drop at first. We had one rabbit we did not expose but otherwise handled in exactly the same way as the others, and that rabbit also showed a drop in the total count immediately afterward; however, it came back to normal in a couple of hours. The other rabbits, on the other hand, showed a later increase, which evidently was due to the radiation. The differential count was changed —the monocytes almost disappeared, whereas the basophiles increased. There seemed to be two such reactions: first, one that lasted a few hours and then a second reaction that lasted for a number of days.

Dr. Bucky (closing): As far as the different questions are concerned, I do not think I will be able to answer them all *in extenso,* because it would take too much time. However, I think I may state safely that all these questions are answered already in the book I mentioned. As to Dr. Stevens' question, there is really a great similarity between the reactions of the Grenz rays, if you apply it generally, and non-specific protein injections; but I do not think we are able to explain these similar reactions by destructive action, either in the skin or anywhere else, because the energies applied to get, for instance, the leukocytic drop, are extremely small. They amount, if I remember correctly, to 15 r-units (I am averaging only), and that on a surface 1 cm. in diameter. The leukocytic drop is characterized by a diminution in the number of leukocytes of about 20 or 30 per cent of the original value, and that takes place—this is important—in the first twenty minutes. Then the number goes up again to normal in about half an hour. These times and figures are important, because you can, as I said in my paper, also produce a leukocytic drop with roentgen rays, but this drop takes place about an hour and a half after radiation. There is a great difference. If you are interested in the explanation, I must ask you to read the respective chapter in my book. However, we cannot say that such a minute energy applied for a few seconds—it takes about fifteen seconds to apply this amount of energy—can produce an amount of destruction apt to change the entire condition of the body, inasmuch as only the leukocytes are diminished in number—not the lymphocytes. Consequently, you will find a relative lymphocytosis within the next half-hour. If you take into consideration the experiments of Petersen, of Chicago, which have shown that those leukocytes missing in the skin are found in the splanchnic system, there is no explanation possible in assuming a destruction. We assume that we have to deal with an action on the autonomic nerve system.

So much for this question, which is quite

difficult, but most interesting. If there is any other explanation, I would be really glad to adopt it, but up to now we have not found it.

So far as the technic for the treatment of internal disease is concerned, we take large fields of the skin—the front and the back of the trunk of the body. Every day one field is treated, and, to cover the entire area, we take a distance of 15 centimeters. We now have new tubes from Europe which cover an area of about twenty centimeters surface, with a distance of twelve to fifteen centimeters, and that seems to be sufficient.

RADIUM IN THE TREATMENT OF DISEASES WITH SUBCUTANEOUS OR MUCOUS MEMBRANE HEMORRHAGES

PRELIMINARY REPORT

By J. M. HOFFMAN, M.D., PENSACOLA, FLORIDA

MY attention was first drawn to the use of radium in these conditions after using it in a case suspected of being acute lymphatic leukemia, presented in 1922.[1] Whereas, we did not use the radium to control the hemorrhages, we were amazed to find that the hemorrhages ceased a short while after its use.

A few months after, an infant niece of a physician was afflicted with severe umbilical bleeding when only a few days old. This hemorrhage continued after the use of all known methods of control, including hemostatic serum and blood transfusions. We applied radium over the splenic area, giving her 300 mg.-hrs. of Gamma radiation. The hemorrhages ceased within twelve hours. Unfortunately, no blood examinations were made on this patient.

My next opportunity to utilize this method was on an infant boy about twelve days old, on April 20, 1926. This child had been circumcised and began to bleed about the sutures. Every known method was tried to control this hemorrhage, including transfusions from both the child's father and mother, without avail. I offered my services to the attending physician, citing to him my experiences in the two cases mentioned above. He was skeptical at first, and another consulting physician was definitely opposed to its use. However, when the child was almost exsanguinated, they decided to "risk" this method as a last resort. I gave a splenic application of 300 mg.-hrs. In eight hours all hemorrhage ceased and the child made an uneventful recovery, without any recurrence up to the present time. Unfortunately no blood examinations were made in this case either.

Some time after, November 24, 1928, a child was sent to the hospital for a blood examination preparatory to a blood transfusion. I was fortunate enough to see the patient, who was suffering from purpura hemorrhagica (idiopathic). The child was not acutely ill, but had developed new purpuric spots over a period of several months and was becoming weaker thereby. We prevailed upon the attending physician to allow us to use this treatment before transfusing, which he did. We gave 300 mg.-hrs. of Gamma radiation over the spleen. In about eight or ten days all purpuric spots had disappeared, nor has there been any recurrence up to the present time. Blood counts revealed no abnormality of the blood other than a severe secondary anemia. Blood platelets were normal in number.

On July 5, 1929, an infant girl was admitted to the hospital, practically exsanguinated. The history revealed that the child had been bleeding from the umbilicus for about two weeks. We applied radium in the same way over the spleen, but the child died after three hours. Coagulation time was eighteen minutes on admittance. No further blood studies were made.

On December 12, 1928, a child two years old was carried into my office bleeding from the mouth. The body was covered with purpuric spots. The history revealed that the child had fallen three weeks before, cutting the inside of his mouth on a tooth. Hemorrhage had been continuous in spite of all the efforts of the attending physician to control it. Upon further questioning we found that the child had developed large subcutaneous hemorrhages when three months old. After that time every fall would cause the development of subcutaneous hemorrhage, or, if the skin was broken,

[1] Lymphatic Leukemia, J. M. Hoffman. N. O. Med. and Surg. Jour., December, 1922, LXXV, 319-323.

an active bleeding. The child had been transfused twice as a life-saving measure to stop the hemorrhage. Upon searching the records, we found that the child had been transfused in this hospital on February 12, 1928. At that time the total erythrocyte count was 1,670,000, hemoglobin 25 per cent, coagulation time 6 minutes 27 seconds. Following transfusion the active hemorrhage ceased after several days but the purpuric spots persisted, developing anew at the slightest blow.

When seen by us on December 12, 1928, the blood examination revealed the following: total erythrocyte count 1,120,000, hemoglobin 30 per cent, coagulation time 9 minutes, with normal platelet count. Physically the child was so weak that he was unable to hold up his head. The genitalia and buttocks were livid with subcutaneous hemorrhage, which the mother stated was due to sitting. I applied 300 mg.-hrs. of Gamma radiation over the spleen. The hemorrhage ceased in twelve hours. (See continuation of report in tabulation below.)

The child had developed several new purpuric spots, and had a severe hemorrhage as a result of a laceration of the toe. We decided to apply radium again. This was done on April 18, 1929, using the same technic. The child's condition cleared up entirely again and he has been entirely well up to the present time. Blood examination made Sept. 18, 1929, revealed a total erythrocyte count of 3,470,000, hemoglobin 60 per cent, coagulation time 5 minutes. The boy has had several falls and minor lacerations without any undue hemorrhage.

SUMMARY

We may conclude from the foregoing cases that radium offers a new and valuable aid in the treatment of hemorrhagic diseases of the newborn, as well as in simple purpura hemorrhagica. In hemophilia, radium will offer help in controlling the severe hemorrhages without the aid of other medication, and may be the means of aiding the organism to eradicate the disease completely. Only after continued use of this method in these conditions will we be able to draw

Blood examinations on successive dates were as shown in the tabulation:

	Total erythrocyte count	Hemoglobin	Coagulation time	
Dec. 18, 1928	1,705,000	35 per cent	7 min.	
Dec. 31, 1928	2,025,000	45 per cent	4 min.	Purpuric spots had entirely disappeared.
Jan. 9, 1929	2,880,000	50 per cent	4 min.	
Jan. 23, 1929	1,735,000	35 per cent	6 min. 35 sec.	

A few purpuric spots had made their appearance and we decided to give another treatment, as before. This was done on January 25, 1929. To resume the tabulation of subsequent reactions:

	Total erythrocyte count	Hemoglobin	Coagulation time	
Feb. 1, 1929	2,225,000	40 per cent	6 min. 15 sec.	Purpuric spots faded; no new spots.
Feb. 9, 1929	2,585,000	50 per cent	5 min. 45 sec.	Purpuric spots entirely disappeared.
Feb. 17, 1929	2,620,000	55 per cent	5 min. 15 sec.	Child appeared perfectly well at this time.
March 5, 1929	4,835,000	55 per cent	7 min.	Child had developed a few purpuric spots.
March 19, 1929	3,865,000	55 per cent	7 min. 50 sec.	
March 28, 1929	3,340,000	60 per cent	10 min. 55 sec.	
April 11, 1929	2,960,000	60 per cent	7 min. 30 sec.	

definite conclusions relative to the permanency of the cures as well as to the actual blood changes which result.

In conclusion, we wish to add a word of warning. If the total erythrocyte count is below 1,000,000, this method must be used very cautiously, due to the hemolytic action of Gamma rays. Preliminary transfusions should be used to bring the blood volume above that level.

EXPERIMENTAL STUDIES

Experiments Regarding the Effect of Roentgen Rays of Different Wave Lengths on the Spleen of Mice, Using Identical Doses Measured in r-units. J. Piepenborn. Strahlentherapie, 1929, XXXIII, 322.

The spleens of mice were studied histologically following exposure of the animals to roentgen rays. Two types of radiation were used: 100 K.V., 2.0 Al., and 180 K.V., 2.0 Cu. Two ionization instruments permitted accurate control of the dose. The most characteristic results were obtained following administration of 150 r and microscopic examination thirteen hours afterwards. The author comes to the conclusion that the observed histological changes in the spleen were alike for both types of radiation. He believes that the quality of roentgen rays does not influence the biological effect if the same number of r-units has been applied.

E. A. Pohle, M.D., Ph.D.

Experimental Investigations Regarding the Relation between Hypophysis and Other Glands of Internal Secretion. Communication II.—Further Experimental Contribution on the Question of Correlation between Hypophysis and Genital System. L. D. Podljaschuk. Strahlentherapie, 1928, XXX, 65.

The relation between hypophysis and ovary is not well understood. Clinically, certain ovarian dysfunctions are being treated by irradiation of the hypophysis. The author attempted to support this procedure experimentally. He used dogs, the doses given being high enough to cause atrophic changes in the hypophysis. There were no changes to be observed in the ovaries of the same animals. He asks, therefore, for further investigations, because certainly the possibility of castration by irradiation of the hypophysis can not be deduced from his experiments.

E. A. Pohle, M.D., Ph.D.

THE ROENTGEN TREATMENT OF MORBUS BASEDOWII

By PROF. DR. G. HOLZKNECHT, VIENNA
Translated from the German by RALPH POMERANZ, M.D., NEW YORK

AS a result of the successful experiments of Williams and Mayo, it has been known since 1904 that morbus basedowii can be cured by X-ray treatment, about 60 per cent of cases showing cure and about 20 per cent improvement to a greater or lesser degree. This success is more noteworthy when one considers the fact that the cases, if not treated, end fatally, or the patients are incapacitated for a long time. That the effect of rays is not a delusion, created by spontaneous cure, is evident from the improvement which as a rule immediately follows the treatments, even in cases in which the patients have been growing steadily worse before. For the same reason, simulated X-ray treatments do not give results.

The successful treatment of the disease is important, not only as such, but also because it helps us to acquire greater knowledge of the action of X-rays. First, we wish to deal with this general point of view, since so will we be helped to understand the accomplishments of the treatment and to achieve results systematically.

For a long time only one group of symptoms of morbus basedowii was known, namely, the well-known functional disturbances involving almost all the organs. The origin of the disease was open to conjecture, the prevailing belief being that it resulted from defective function of the sympathicus, *i.e.*, a sympathicus neurosis. Electric treatment of sympathicus is a relic of this theory. Less popular was a second hypothesis, that a diseased thyroid was responsible. It is of great credit to surgery to have discovered the nature of the disease and to have proved the second theory. The removal of part of the thyroid gland, *i.e.*, a quantitative reduction of the hormones secreted into the blood stream, causes a disappearance of the disease. This fact proves the thyroid to be not only the seat of the disease, but also its cause, a hyperproduction of hormones, a hyperthyroidism. The suggestion that malfunction of the gland, and not hyperfunction, might cause the disease was thereby disproved. The question remained open whether, outside of hyperproduction, some qualitative deviations might not occur which would cause atypical pictures of the disease. (This would not rule out the possibility of development of hyperfunction of the thyroid gland by some external factors, such as fright, use of iodine, or postpartum changes.) The opposite picture, hypofunction of the thyroid gland (myxedema), is also known. Surgically, it can be produced by operative removal of the whole thyroid, and cured by implantations of the thyroid gland, or by feeding thyroid extract. This applies as well to the clear quantitative functional disturbances in both directions with anatomically unchanged organs, as, for example, with tumor-like hypertrophy on one hand and atrophy of the gland on the other. There is no other organ about which these conditions are so well known as of the thyroid. For this reason the action of X-rays can be studied and tried out on this organ with exact results. The conclusion is that *their action is inhibition or depression of the growth and function of the cells.* X-rays cure in hyperfunction and secretory hyperplasia in the same way as does surgical reduction, and they may cause hypofunction when applied in excess just as complete removal of the thyroid gland will. This parallel with surgical effects holds for all degrees of treatment as well: insufficient irradiation in hyperthyroidism will give insufficient therapeutic effects, just as will insuffi-

cient surgical reduction. That stimulation of the secretory function of the gland never occurs can be seen from the above evidence. This evidence also confirms the well recognized fact that a cure of myxedema and cretinism by application of small dosages according to the Arndt-Schulz law is impossible. On the contrary, radiation treatment is strongly contra-indicated in these conditions. *Retardation, depression, and reduction in direct quantitative proportion is the essence of action of X-rays.*

From the action of X-rays on normal tissues and tumors, the above fact has been known to be true for tissue growth and stability, but at present we are speaking of the depressive action of rays with regard to tissue function. It is well to note that the principal support of this theory is found in the experiments with the diseases of thyroid gland, particularly morbus basedowii. It is unnecessary, in my opinion, to emphasize the significance of this fact. The knowledge of the action of X-rays helps in establishing the indications for treatments, and in modifying these, according to all the irregular courses, forms, or variations observed in individual cases. One observation disturbs the clearness of the conception, *i.e.*, the aggravation of symptoms of hyperthyroidism following treatment, applied not in small doses, but in one large dose in a single day, *e.g.*, fairly large doses through three fields. The recurrence of such aggravation was prevented by division and diminution of each dose, particularly of the first one. The explanation of this phenomenon was finally found by Pordes to be as follows: A sudden excretion of all the material accumulated in the cells preceding the hypofunction, the "initial *Inkretstoss*," is the cause of the above aggravation.

This brings us from the theoretical consideration of the action of rays on morbus basedowii to their therapeutic use. The thyroid gland is the organ to be treated. It is still questionable if the treatment of the thymus in morbus basedowii, done by many, has any significance. It *seems* to have some. (The treatment of other diseased organs which may sometimes interfere with the cure, or may be the causative factor of secondary morbus basedowii, as, for example, Chvostek's gall-bladder attacks, does not belong in this discussion, even though at times their treatment may be of some value.)

Fields.—In general, one anterior field is sufficient. When large enough, it has the advantage of reaching the substernal goiter and the thymus. A persisting thymus often reaches the cardiac apex. In large thyroids two fields should be taken, using the 180 degree angle according to Holfelder. Both larynx and lungs should be protected. The superficial location of the thyroid and the triangular cross-section of the neck are not very favorable to homogeneous radiation. However, in general, 150 to 170 K.V., at from 30 to 40 cm. skin-focus distance, with ½ mm. Cu., gives a beam sufficiently homogeneous. I cannot refrain from remarking that I can remember the excellent results secured twenty years ago with no filtration whatsoever. However, I may have been carried away by the enthusiasm of my youth.

Dosage.—The more severe the case, the smaller should be the dosages, particularly the first one, in order to prevent the *"Inkretstoss"* aggravation—let us say one-fourth to one-sixth of the Holzknecht erythema dose on the skin. Each application, however planned, should be dependent upon the effect of the previous one, so that an interval of several days, usually a week, is necessary. All symptoms should be considered, not only the characteristic ones, but the minor ones as well. Their significance is greater, inasmuch as metabolic tests cannot always be done nor exophthalmos measured. The pulse is changeable, and the weight may deceive. All symptoms should be recorded in

a carefully taken history, always available for comparison. Let the motto be: *"Consider everything and overestimate nothing, not even the metabolic test."* The course of this test may be very irregular and should be controlled by testing the excretion of creatinin in the urine (Feldman), which may be done easily at any time. The extreme limit for the total dosage is the skin tolerance. It has often been stated that the skin and tissues of hyperthyroid patients are more susceptible to X-rays than are those of normal persons. This is not true except for a transitional skin reaction which, if occurring at all, may be stronger.

The courses of the disease are manifold. We do not know enough about the failures in treatment. Among these are cases of acute morbus basedowii, with considerable daily loss of weight and ending fatally in a short time. Perhaps this type of case still receives too much radiation. On the other hand, there are the chronic cases, lasting for years and even decades, which are in metabolic equilibrium but show cardiac and anatomical symptoms. These patients are products of their neurotic degenerative environments, which really are the contributing conditions, the individual bases, upon which hyperthyroidism develops into morbus basedowii. Old chronic hyperthyroidism in these degenerative individuals forms the majority of failures. The glandular tissue, slightly hyperproductive and stabilized in this condition, is little, or not at all, susceptible to X-rays. For the same reason the therapeutic dosages applied to normal thyroid tissue will have no effect, and it is impossible to produce myxedema or any other hypofunction by irradiation of normal thyroid. This fact was established by intensive treatment of neck tumors in which in only three cases were myxedematous symptoms produced. This is very important; it automatically guards against excessive radiation, and makes the entire application a harmless procedure.

Sometimes a potential failure in treatment turns to success as a result of an intermediate course of insulin treatment or, still better, after a rest cure in the mountains. May I give my opinion in this matter, based upon my extensive experience of many years of observation? Weather conditions are not the reason for the cure. The altitude takes away the summer heat, the trees take away the noise and excessive light. The elimination of all the irritating factors, together with the peace of body and soul, may not be active therapeutic measures, but they provide the external conditions for spontaneous retrogression of symptoms when susceptibility is present, or is produced by the treatment. Cases not helped by doctors instinctively go to the mountains. In the Middle Ages, in my opinion, women afflicted with morbus basedowii settled in solitary mountain huts, and so found relief from their disease. Unfortunately they were not left alone, for, because of their fearful appearance, irritability, and leanness, they were considered witches. This, I believe, was the basis upon which witchcraft was founded.

Very often the irradiation takes full effect in spite of most awkward life conditions. Nevertheless, the elimination of irritation should be attended to, even during the X-ray treatment. The present technic does not fulfill this demand. If these patients, who are highly susceptible to fear, are left alone in these (to them) mysterious therapeutic rooms, and if they observe that, not only the nurse, but also the physician, dare not come in, then we are not doing anything for them which is useful. The equipment should be so arranged that we (physician or nurse) can sit down beside these irritable patients, hold their hands, let them see that there is no danger, and assure them that there is nothing to endure but the

passage of time. In light cases I have occasionally seen the best results among the high pine trees of Poland, and good results from rest cure in general—from the peace and coolness of old thick-walled houses. The other conservative measures play no important rôle.

Even in successful cases the course of the disease is variable: it defines only the dosage. Its extent is without importance, even seemingly hopeless cases ending happily. For the rapid, the slow, or the very slow recovery, the important thing is the previous course of the disease. If it has developed slowly, with long intervals, then the change (stabilization of weight) follows the treatment immediately, but the improvement is slow. Cases which have developed rapidly recover in the same manner. When, however, after slow development of the disease, the condition is suddenly aggravated, then the treatment will be followed by rapid recovery but only to the stage from which the aggravation developed. This I have called a "reflected image" of the course of disease caused by the treatment. Evidently the reason for it is the greater susceptibility of hyperactive tissue, and the lesser susceptibility of the less active glandular tissue. The difference cannot be compensated for by dosage.

I do not have to emphasize that the functional symptoms (loss of weight, palpitation, irritability, and fear) are first to retrogress, rather than the anatomical symptoms —exophthalmos, and the struma, which may persist even permanently.

We would not have to discuss contra-indications at all, had not a mistake of eighteen years ago, now proven incorrect, gained such wide publication. That is: that the rays cause pericapsular inflammatory adhesions of the thyroid gland which render operative procedure difficult, if such should be necessary. This mistake has been used as a weapon against application of X-rays in morbus basedowii. Since then it has been proved by many statistics that adhesions after X-ray treatments are no more frequent than their occurrence without treatments. They are usually a result of strumitis after infectious diseases of childhood. We know from our special X-ray experience that inflammatory changes of the connective tissue, even after large dosages over any part of the human body, *do not occur* when the skin is intact (no X-ray ulcer). For this reason ripe connective tissue stands on the lowest grade of the scale of susceptibility. All these facts, however, did not help, for the medical world was too anxious to accept contra-indications against X-ray treatment. This can be understood if one considers what a revolution would be created in the medical profession if all the X-ray therapeutic indications were accepted in such a short time. Medicine is a very difficult field of human endeavor: The patients should not wait; the innovations, however, are difficult to learn and to test, and only gradually do they gain the confidence of physicians.

Finally, it is necessary to consider roentgen therapy in the light of all other useful therapeutic measures, and to give it the correct sphere of indications among the various stages and varieties of morbus basedowii. Scientific considerations of most therapeutic measures usually fail to state when these or other useful measures should be employed. The result is that all the methods of treatment occupy an equal place in the literature, and it is the physician's task to make his selection. This is one of the main reasons for complaints against a lack of order and clearness in the excessive amount of medical literature. Comparative therapy is, however, a very difficult but necessary field of discussion, and should be considered in any scheme of therapeutic measures. In the case of morbus basedowii, the only two active therapeutic measures are in competition:

the operative procedure and the roentgen reduction. Of the non-active measures, the elimination of bodily and psychic irritation, and all the psychotherapeutic methods serving them, can be considered as one. To the latter group belong necessarily all the light cases and the beginning stages of the disease. They remain in this group when spontaneous recovery takes place in a relatively short time. The expectant procedure should not last many months because of the previously discussed stabilization of the hyperproductive thyroid tissue and its anatomical results, which, if it has taken place, will considerably diminish the success of active measures. Unfortunately, it is common to try out first all the conservative measures, very often in succession, for many months.

The active measures, as I have stated above, have many points in common: they have the same point of attack and the same tendency. Neither is lacking in failures, since one must often be employed after the other has failed. Particularly, radiation fails to relieve the pressure caused by a large struma. On the other hand, an introductory X-ray treatment may dispel the fear of operation and shock. Both methods can be quantitatively graduated: of course, the fine gradation is different in each case because of the different technics. Both have their dangers, which should be evaluated from different angles. On one hand, death may occur from shock, infectious venous thrombosis, or recurrens paresis, all of which may be unforeseen, or may be inevitable. On the other hand, X-ray damage still occurs, notwithstanding the fact that, to-day, all the remedies for prevention are available. I do not know of any case of morbus basedowii with X-ray damage, a condition which is probably due to the small dosages used. In any event, the dangers of the two procedures are widely separated, and this is the deciding point. After a few weeks of expectant procedure, or after a remission following the same, X-ray treatment should be introduced. This should be done even more promptly in those cases which may not respond to treatment, if delayed to a chronic state, yet are not chronic enough to demand operation.

A very acute case of morbus basedowii should be operated upon because of the quick relief which ensues. Cases not responding to X-ray therapy and those first treated by X-rays but showing signs of tracheal compression caused by large nodular struma, should also be operated upon. The deciding factor is the danger of the procedure. As is evident, one does not lack information in deciding upon the method of attack.

In conclusion, we note to our great satisfaction that the wide gap which existed in the past between medical and surgical procedures has been filled by roentgen therapy.

CONCLUSIONS

The correct interpretation of either improvement or aggravation (pre-reactive) following X-ray treatment is often confused by suggestions of the same. Either may occur, according to whether hope and reliance in the physician on one hand, or personal fear and anxiety on the other, prevail. Therefore, the suggestive actions should be eliminated, or recognized, by the test of a simulated X-ray treatment because of the importance to decide whether the treatment should be continued or postponed, and whether the change is caused by irradiation or other factors.

The first X-ray treatment, at least, should be a simulated one. If, after this, the patient shows either considerable improvement or severe aggravation (either could occur after a genuine treatment and might compel us to discontinue), then we know that such condition is not the result of X-rays. In all cases showing many subjective symp-

toms, a simulated X-ray treatment should be employed because of the great suggestive action of the roentgen procedure. It separates the superimposed neurotic symptoms from the pertinent ones.

Operative experience is abundant, yet nothing is known about it. The large operative hemorrhage was one of the results of the so often discussed pericapsular adhesions which render a clean, bloodless removal of thyroid tissue difficult. This factor has been ruled out by statistics which prove that the adhesions, if found, were already there before the treatment, and that they occur just as often in untreated as in treated cases. There is no reason at all for giving up the local treatment of the thyroid, and there is no basis whatsoever for resorting to the general skin treatment with the Grenz rays, as advocated by some.

X-RAY DIAGNOSIS AND THERAPY OF THYROID DISEASE[1]

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THE rôle of roentgen rays in the diagnosis of thyroid disease, though limited, is nevertheless an indispensable one in establishing the diagnosis of a substernal extension of the thyroid into the superior mediastinum, and therefore a routine X-ray examination of the chest should be done in all thyroid cases. The bulging in the cervical region is clearly visualized by the X-rays, but there is nothing diagnostic about the shadow which can in any way assist in the diagnosis nor supplement the physical findings of palpation and inspection, except to indicate whether calcification is present in the gland. One must, however, stress the importance of a routine examination of the thorax to rule out a substernal extension. Such routine examinations are done at the New York Hospital by request of both surgical divisions before operation is attempted.

When a substernal extension of the thyroid is present, the shadow cast by the roentgen rays is characteristic. The shadow is usually, though not always, bilateral and symmetrical, and is triangular in shape. The base of the triangle is upward, in the root of the neck, and can often be seen to be continuous with the shadow of the enlarged thyroid in the neck. The apex is directed downward, usually merging with the shadow of the aortic arch. The lateral margins are smooth in outline, clear-cut, and stand out sharply against the lung tissue. A most characteristic finding is a displacement of the trachea—forward or to either side. Not infrequently the lumen of the trachea is narrowed.

It is well to bear in mind that the hypertrophy of the thyroid may be entirely substernal, with no appreciable thyroid enlargement in the neck. For this reason, if for no other, all cases with symptoms of exophthalmic goiter or toxic adenoma should have a radiographic examination of the thorax. The differential diagnosis is usually not particularly difficult as the pathological conditions occurring in the superior mediastinum in this region are not numerous.

Aneurysm of the aorta can usually be easily differentiated in that it is not bilateral and symmetrical and also is situated lower in the thorax. Further, on fluoroscopic examination the aneurysm can be seen to pulsate, whereas the thyroid shadow does not pulsate.

Thymus.—An enlarged or persistent thymus may be differentiated by the fact that, although it too is triangular, the triangle is in the reverse position to the triangular shadow of the thyroid; that is, the apex is directed upward and the wide base downward, merging with the shadow of the base of the heart. The thymus shadow is frequently referred to as being keystone-shaped and fitting down over the base of the heart like a cap. It is very rare to encounter any appreciable shadow of a thymus in an adult, despite the fact that in numerous cases of toxic goiter hyperplasia of the thymus is present.

Hodgkin's Disease.—The adenopathy of Hodgkin's, when occurring in the superior mediastinum, gives a very different shadow from the substernal thyroid in that it can be seen to be made up of separate shadows, which, even when confluent, give a lobulated appearance. It is also very rare to encounter a deviation of the trachea as a result of the glandular enlargement of Hodgkin's disease.

Another type of Hodgkin's disease which

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causes a large mass in the mediastinum is differentiated by the fact that it is not bilateral and symmetrical; that it shades out toward its periphery and does not show a clear-cut margin such as that caused by a substernal thyroid, and lastly, that it is situated lower in the chest.

Tuberculous Mediastinal Adenitis.—This condition need cause no confusion as it is usually most pronounced in the region of the hilus of the lungs, and, as a rule, the outline of the enlarged glands is fuzzy and not clear-cut in appearance. A deviation of the trachea in tuberculous adenitis is quite common, so that this sign is of no assistance in a differential diagnosis.

Benign Tumors.—These may be encountered in the superior mediastinum but are practically always unilateral, quite rare in the incidence of their occurrence, and present a very different clinical picture.

Thymoma.—This is easily differentiated by its occurrence much lower in the mediastinum, by its large size and rounded disc-like appearance.

Malignant Neoplasms.—These rarely occur in the same location as that in which the shadow of a substernal thyroid is seen, either when primary or secondary. They are, if due to carcinoma, usually quite irregular in outline and show a definite asymmetry. It is generally possible to find other evidence of carcinoma in the lungs or in other portions of the mediastinum, and one may be fortunate enough to encounter a metastatic process in the ribs.

Sarcoma may be differentiated by its large size, by its being lower in the mediastinum, and by the fact that if a careful observation is made, the typical sharply outlined, rounded metastatic masses in the lung may be seen.

The above, of course, does not apply to malignancy of the thyroid.

The beneficial results following the use of the roentgen ray as a therapeutic agent in certain types of goiter have long been recognized and accepted. The literature of the past fifteen years contains numerous articles and gives case reports upholding this view.

In 1913 Stoney gives a comprehensive report of 48 cases treated by the roentgen ray, with 14 cases cured, 22 benefited, and 4 not helped; 7 discontinued treatment without being discharged, and 1 died in a subsequent operation.

In 1916 Pfahler and Zulick made an exhaustive review of the literature and published the results of the work done up to that time by themselves and others. In 1919 Holmes reported the results of his treatment of 262 cases and reviewed the literature up to that date. Since that time numerous articles have been published, all reporting cures or marked improvement in a large percentage of these cases, Simpson, Haudek, and Kriser claiming improvement or cure in 90 per cent of the cases treated.

While numerous classifications have been suggested, the present authors feel that the following will be found to be a convenient one:

Malignant neoplasms, *i.e.*, sarcoma and various types of carcinoma.

Degenerative changes in the thyroid, *i.e.*, colloidal and cystic.

Toxic changes in the thyroid { exophthalmic, adenomatous.

The colloidal and cystic goiters should never be subjected to the roentgen ray, as there is no evidence of inflammatory processes and no toxicity. As these are end-results, no benefit will be obtained. If they cause pressure symptoms, they should be referred to the surgeon. Furthermore, these types should consult a surgeon because of the possibility of malignant degeneration.

Cases of malignant neoplasm of the thyroid should be operated on as early in the disease as possible and subjected to post-operative radiation. If for any reason the case should be inoperable, radiation should

be given, which will bring about an amelioration of the symptoms and possibly arrest the progress of the disease. Holmes reports one such inoperable case, recurrent, the patient dying of an intercurrent disease three years after radiation.

Substernal thyroid, while not common, occurs not infrequently and is often overlooked until distressing pressure symptoms call attention to the condition. Unless one is accustomed to dealing with thyroid disease, substernal thyroid is most readily recognized by radiography. It is generally considered to be a surgical condition, and Lahey is positive in his assertion that "surgery is the only curative procedure." While this is undoubtedly true in cystic, colloidal, and non-toxic types, yet in the toxic adenoma the X-ray is frequently of value, particularly in those cases which are poor surgical risks or in which there is little chance of a successful result. Grier calls attention to the fact that often, while radiographically there may be no appreciable reduction in the size of the goiter, marked improvement in the symptoms will follow. He reports 13 cases free from symptoms three years after treatment. Since the advent of the high voltage technic the results have been more satisfactory. The factors used in our clinic have been: 200 K.V.; 4 ma.; 50 cm. distance; filter Cu. ½ mm., Al. 1 mm.; time ½ hr. anterior and ½ hr. posterior. This treatment is repeated in from five to six weeks.

The types of pathological thyroids which are amenable to roentgen-ray treatment are those in which there is a toxicosis, and this must be present if favorable results are to be obtained. So it is the toxic exophthalmic goiter and the toxic adenoma with which we have to deal.

Effects of the X-ray.—The thyroid, being composed of glandular tissue and closely allied anatomically to lymphoid tissue, is readily affected by radiation. This effect is first inhibitory, the degree depending upon the intensity and frequency of the exposures; second, as the result of repeated X-ray exposures, permanent inhibition, deterioration, and absorption—an atrophy of the cells—takes place, which may be replaced by connective tissue, with total loss of gland activity, myxedema resulting in those cases in which treatment has been carried too far.

Technic.—For successful results in these cases it is important that there be close cooperation between the radiotherapeutist and the attending physician, a careful and thorough physical examination being of prime importance, to find and correct any source of focal infection, which, if not removed, will render valueless all treatment directed toward the thyroid. Especially should sinuses, tonsils, and teeth be examined, as these are the most frequent points of infection. Careful examination of the ovaries and a thorough menstrual history should be obtained, as it is a well established fact that there is a close relation existing between the function of the ovaries and the thyroid, and the hyperthyroidism may be merely a manifestation of endocrine imbalance. The possibility of tuberculosis must be borne in mind, as some authors call attention to the relation of these two conditions.

Practically all writers agree that hypertrophy of the thymus is found in a large majority of the cases of exophthalmic goiter, a fact which is borne out by the reports of postmortem findings, and Rowe says that investigation shows its presence in 65 per cent of cases operated on for exophthalmic goiter. This fact must be kept in mind in the conduct of the case. In those cases in which the toxic symptoms are prominent, and in which the nervous manifestations and tachycardia are severe, rest is an important adjunct, and its importance is in proportion to the degree of toxicity. Patients on the verge of collapse should not be radiated until the condition has been im-

proved by rest. Baker reports two such cases treated, death resulting forty-eight hours later.

Of prime importance and probably the best guide for the manner and duration of radiation is the basal metabolism of the patient, as it supplies the best means of determining the intensity of toxicity and by its use one of the great dangers of producing myxedema is practically eliminated. Holmes, we believe, was among the first to call attention to this, and he lays particular stress on its value. It is important that this test be done before the treatment is undertaken and just previous to each exposure, preferably on the day of treatment.

The importance of the basal metabolism test is emphasized by the following case. The patient, Mrs. A., was referred for radiotherapy. Examination revealed an appreciable enlargement of the thyroid; pulse 100; slight tremor; loss of weight. Before beginning treatment a metabolism test was insisted upon, which showed a metabolic rate of —14.

While a general plan can be suggested, each case, being an individual one, must receive treatment according to its symptoms and severity. The methods advocated by the different authors vary, one group advocating frequent exposures of low intensity, and another giving exposures of high intensity at less frequent intervals, the latter method being the one most generally employed.

At the New York Hospital it has been found that the best results have been obtained with the following plan of treatment: Using an 8-inch spark gap, 5 milliamperes, 10-inch focal distance from the skin, filtered through 3 mm. of aluminum, an exposure of 3 to 5 minutes is made, giving from 1/3 to 2/3 of an erythema exposure. Three portals of entry are used—one over each lobe and one over the thymus. Unless there is some particular indication, the isthmus is never exposed. The reason for this is twofold: first, by protecting this part of the gland the danger of myxedema is practically eliminated; second, the danger of voice changes is overcome. Prolonged heavy radiation over the larynx may cause temporary or even permanent aphonia.

The second exposure is given in two weeks, and subsequent exposures every three weeks. After the third or fourth treatment, if the improvement in the symptoms and rate of basal metabolism is satisfactory, further radiation is postponed for one or two months, when a second series of two or three, or more, exposures is given. This may have to be repeated three or four times, the indication for treatment being based on the basal metabolism, no treatment being given after the metabolism reaches +10. The patient is then kept under observation for one year, being required to report every one to two months; and at each visit a basal metabolism test is done.

It has been observed by the authors, as well as other workers, that there may be an exacerbation of symptoms almost immediately following the first exposure. When this occurs it is advisable to increase, at the second exposure, the intensity of the exposure, and this increased radiation is varied with the condition of the patient in subsequent treatments.

Order of Improvement.—The first symptom to improve is the nervousness, and at about the same time there is a diminution in the pulse rate. This is usually noted after the second, but occasionally after the first, treatment. At times it is not until after the third exposure that improvement begins to be manifest; and if, after four radiations, the case shows no favorable response or progress, it is deemed wise to discontinue X-ray therapy and refer the case for other treatment. With the improvement in the nervousness and tachycardia, the dyspnea is lessened, and the choking sensation of

which these patients complain is relieved. The tremor decreases, and an increase in body weight is noted.

The goiter and exophthalmos are the last symptoms to be affected. The former may not disappear entirely, but usually there is a marked diminution in its size. The latter may not be affected, although, with the increase in weight and the filling out of the patient's face, it becomes less noticeable.

Duration of Time.—The experience of the writers has been that it requires from seven to twelve months to effect a cure. This, however, varies greatly, some authors reporting cures all the way from four to thirty months.

Reasons advanced against the use of the X-ray in this condition are as follows:

(1) *Length of Time Required.*—While it is true that even in a favorable case the time required to produce a cure is a factor, still the improvement is noted early—in most cases as soon as, or before, the patient would have recovered from the effects of an operation.

(2) *Mortality.*—There are a few cases reported in which X-ray treatment has been followed by death. Careful investigation, however, shows that they were cases unsuitable for radiation, and death was due to complications and not to the X-ray, while Glasserfeld reports a mortality of 5 per cent from surgery in 2,023 cases.

(3) *Difficulty of Operation.*—Great stress has been laid upon the claim that radiation increases the difficulty of operation, due to an increase in periglandular fibrous tissue. There is considerable doubt as to the accuracy of this view. Haudek and Kriser say that Pfeifer, Menenow, Krause, and Rave report that they have never found tissue changes attributable to the X-ray which complicated subsequent operation on the thyroid, and that this is borne out by animal experimentation. Many others report similar findings. Certain it is, that a few treatments will not cause connective tissue changes around the gland, and it has already been stated that in cases in which there is no improvement after the fourth treatment, operative measures should be employed.

(4) *Burns and Telangiectasia.*—These can scarcely be raised as objections as they are solely the result of faulty technic. The exposure should never be sufficient to cause an erythema, nor should the number of exposures be carried to the point of an atrophy of the skin and underlying tissues, which must have occurred if telangiectasia has been produced.

(5) *Myxedema.*—By properly shielding the isthmus and controlling the intensity and frequency of radiation by the basal metabolism this can hardly occur.

(6) *Recurrence.*—Some claim that the results are not permanent and that there are recurrences. While in a percentage of cases this may be true, it is believed to be the result of insufficient radiation and failure to keep the patient under observation for a sufficient length of time. At the first evidence of a return of symptoms further radiation should be given.

CONCLUSIONS

1. That in X-ray, properly applied, we have a safe therapeutic agent.

2. That certain cases of toxic goiter should be given the benefit of radiation for at least four treatments. If satisfactory improvement is not noted at the end of this time, radiation should be discontinued, and the case regarded as surgical. If the improvement is satisfactory, radiation should be continued.

3. That radiation does not increase the difficulty of subsequent operation.

4. That radiation before operation renders a patient a better surgical risk.

5. That the danger of hypothyroidism is negligible.

6. That the basal metabolism test is an important adjunct and that the treatment of every case should be governed by it.

7. Severe cases should be hospitalized and a period of rest obtained before treatment is begun and following the first one or two exposures.

DISCUSSION

DR. P. A. WHITE (Davenport, Iowa): I think a word should be said regarding the change in the surgical treatment of thyroid disease in recent years. I have attended the meetings of this Society during a time when operation in certain cases of severe thyroid disease was a great hazard. Lugol's solution, introduced by Plummer, has changed thyroid surgery more radically than anything else except, perhaps, the treatment of diabetes with insulin. I think that, as physicians, we are prone to forget our common sense in enthusiasm for certain methods of therapy. We should consider ourselves as ordinary laymen occasionally and apply common sense to medical problems.

No doubt radiation of exophthalmic goiter or hyperplastic tissue has a favorable effect, though it takes a long time for its benefits to accrue, during which time the viscera are sustaining additional damage. There are a number of factors in the treatment of adenomas of the thyroid, however, that come into this common sense consideration.

We are in the unfortunate position often, in operating on adenomatous goiters, of having to radically change our ideas about what these tumors are like. They frequently look considerably different when they are on a platter and cross-sections are made than our limited means of examination before operation had led us to believe they would. One author spoke of cystic goiter as being amenable to X-ray. The difficulty of telling exactly what kind of a lump this is seems to me insuperable in many cases. As to whether an adenoma is cystic, calcareous, hemorrhagic, or degenerative colloid is usually impossible to tell previous to extirpation of the gland. Many times what I considered might be a malignant thyroid, because of its density, has turned out to be only a recent hemorrhage into a cystic degenerating colloid adenoma, with an enormous blood clot in the cyst. Just what effect radiation would have on this blood clot certainly is pertinent to this discussion.

There is another factor to be considered in dealing with adenomas. Often the basal metabolism is low, the progress of the disease is very insidious, and the most expert experienced thyroid clinicians are sometimes put to the test to tell a toxic thyroid from the non-toxic condition. The deleterious substance which is poured into the blood stream has a selective effect on the heart muscle. These cases go for years undiagnosed and after a time develop cardiac symptoms. Then, too, we often find fibrillation and myocardial deficiency, while the hazard of operation has greatly increased by the time the condition has at last been connected with adenomas of the thyroid.

The safety of thyroid surgery in recent years should be emphasized. I heard Dr. Sistrunk make the statement very recently that in the last eleven hundred cases of exophthalmic goiter (I think this is a point that should be considered in thinking of the time element in X-ray treatment), operated upon in the first year of the disease, there were only two deaths.

The immediate result following thyroid surgery is a fact to be recognized. It has been our fortune—or misfortune—to have had a number of women of advanced age to operate upon during the past few months. Last Friday morning I operated upon a woman seventy-three years of age who had

been ill for over two years from the toxicity of a mixed exophthalmic goiter and toxic adenoma. When I left home on Monday night she was practically normal insofar as her heart rate, nervous symptoms, and mental state were concerned.

Complete ablation of goiter symptoms without persistence or recurrence is another thing that needs to be considered. We have re-operated upon only two cases in seven years. One patient, a man, will serve for illustration. About seven years ago I removed what I considered the major part of the thyroid gland. He improved remarkably, gained in weight from one hundred twenty up to about one hundred sixty pounds and went about his work. Often under stress he would feel the old symptoms of warmth, perspiration, and tremor. He returned in about a year and I said, "It looks as if we will have to do further surgery." On going into his right thyroid fossa I found behind the trachea a lump of thyroid tissue about half the size of an egg. In the stress of the previous operation, which was before the days of preparation with Lugol's solution, it had been overlooked. He regained his stability for a time but returned a year later with some of his symptoms of weakness, feeling of heat, sweating and tachycardia, and inability to carry the full stress of his work. A little nodule just over the right upper edge of the thyroid cartilage, not larger than an almond, was palpable. We removed that with a little local anesthetic and since then he has had no further symptoms of hyperthyroidism.

I wish to stress the points of the persistence of symptoms from a very small amount of hyperplastic tissue, the immediate and complete results following adequate operation early in the disease, and to emphasize the relative safety of thyroid surgery to-day.

Dr. Webster W. Belden (closing): There is not much that can be added in closing except to correct what is evidently a misunderstanding. One of the discussants of our paper seemed to gather that we advocated treating cystic goiter by means of the X-rays. This is in error, since there is no such statement in our paper.

Cystic goiters should never be treated by X-rays, nor should simple adenomas be so treated. The only type of thyroid disease in which roentgen therapy is of value is the toxic goiter, whether it be exophthalmic goiter or toxic adenoma.

There is no other point that needs stress of emphasis.

We, however, do not wish to make the claim or leave the impression that we feel that the roentgen rays are the only therapeutic measure for thyroid disease. Surgery and medical treatment are also exceedingly valuable. We would like to stress the point, however, that each individual case must be treated as an individual. We cannot treat all thyroid cases by simply using a given kilovoltage, a given milliamperage, with a given filtration and given distance. In other words, these most complicated cases cannot be treated by "the rule of thumb." Let us remember to avoid being automatons, because, if we do not, our results will not be satisfactory either to ourselves, the patients, or the medical men referring them to us.

CASE REPORTS AND NEW DEVICES

DIAGNOSTIC PNEUMOPERITONEUM IN DIAPHRAGMATIC PATHOLOGY

By N. S. ZEITLIN, M.D.
Department of Roentgenology, Cook County Hospital, CHICAGO

Pneumoperitoneum is not new, but we believe that its value with particular reference to sub-diaphragmatic pathology is not fully appreciated, or else we have been exaggerating the difficulties which we have experienced in the past, in the differentiation between supra- and sub-diaphragmatic lesions.

It is a well known fact that pathology starting below the diaphragm will sooner or later involve the pleural cavity to such an extent that the chest findings may entirely obscure the abdominal symptoms and thereby give rise to an erroneous diagnosis. When such a case is subjected to fluoroscopy, it is seen that the fluid in the chest fuses with the shadow of the dome of the diaphragm. Frequently the level of the dome cannot be differentiated from the shadow of the pleural effusion, and since the position and mobility of the diaphragm is of paramount importance in the diagnosis of sub-phrenic pathology, we have frequently failed to make the correct diagnosis.

This differentiation is of vital importance because of the frequent necessity of opera-

Fig. 1. Case 1. "The first X-ray finding indicated post-pneumonic markings, and probably an abnormally high position of the dome of the right diaphragm."

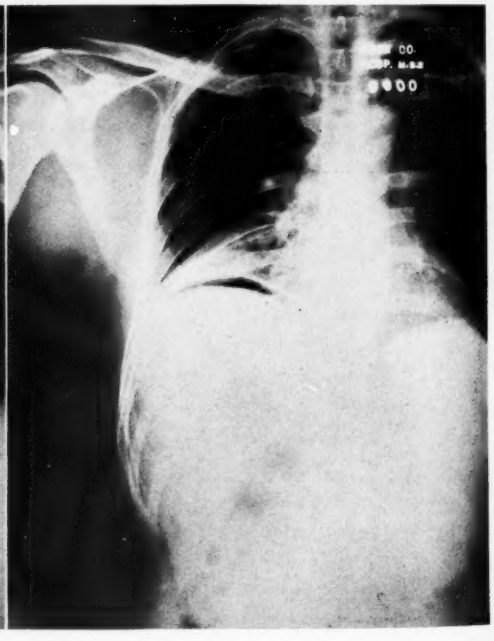

Fig. 2. Case 1. "The clear air space above the dome of the right diaphragm, which is normal in position. The pathology is seen to be entirely above the diaphragm."

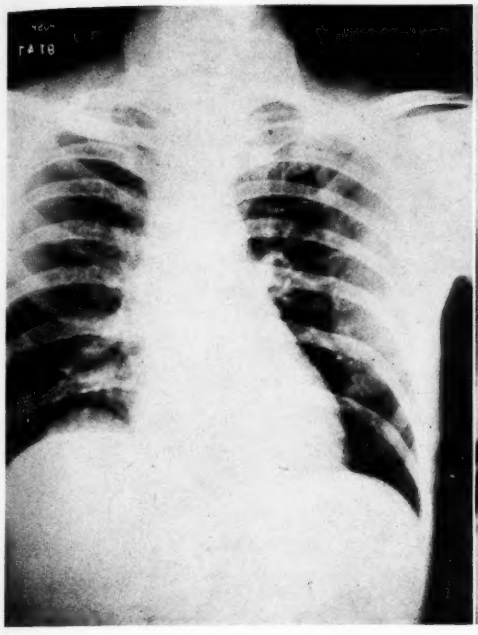

Fig. 3. Case 2. "The first X-ray film shows a bulging shadow protruding upward from the right half of the diaphragm."

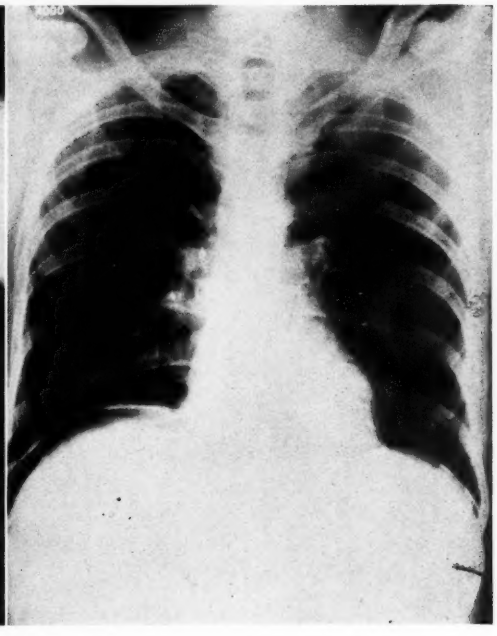

Fig. 4. Case 2. "The shadow appeared to be within the pleural cavity—either pleural effusion or a pleural tumor."

tive procedure. Following several serious mistakes in diagnosis, it was determined to revive the procedure of injecting air into the abdomen. Under ordinary conditions this air will rise to the sub-diaphragmatic space when the patient is in the upright position, so that the height and excursion of the domes can be easily studied.

We wish to report the significant results in the following cases.

Case 1, I. S., age 34. Nine days previous to his entrance the patient had a chill and a sudden pain in the right upper quadrant of the abdomen. Clinically a diagnosis of post-pneumonic empyema was favored. After a fruitless pleural puncture, the diagnosis of sub-diaphragmatic pathology was suggested and X-ray examination recommended. The first X-ray finding (Fig. 1) indicated post-pneumonic markings, and probably an abnormally high position of the dome of the right diaphragm. The exact height and the excursion could not be determined because of the confusing shadows in the chest. Further clinical examination at this time indicated a probable sub-diaphragmatic abscess, and operation was recommended. A pneumoperitoneum was urged as a last resort for a diagnosis. This was done and 200 c.c. of air was injected. Figure 2 shows the clear air space above the dome of the right diaphragm, which is normal in position. The pathology is seen to be entirely above the diaphragm. In this case the pneumoperitoneum prevented a useless operation.

Case 2, J. R., age 35. The patient gave a history of dysentery, diarrhea, and pain in the right upper quadrant of the abdomen. A clinical diagnosis of liver abscess was made. The first X-ray film (Fig. 3) shows a bulging shadow protruding upward from

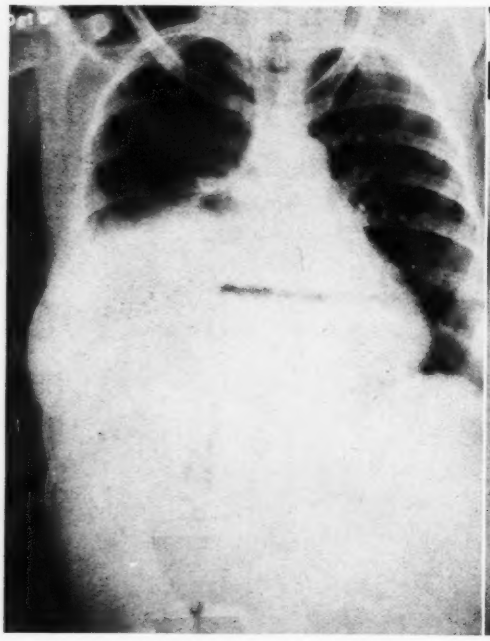

Fig. 5. Case 3. "Fluoroscopic examination failed to differentiate the right half of the diaphragm from the shadow of the moderate amount of fluid in the right pleural cavity."

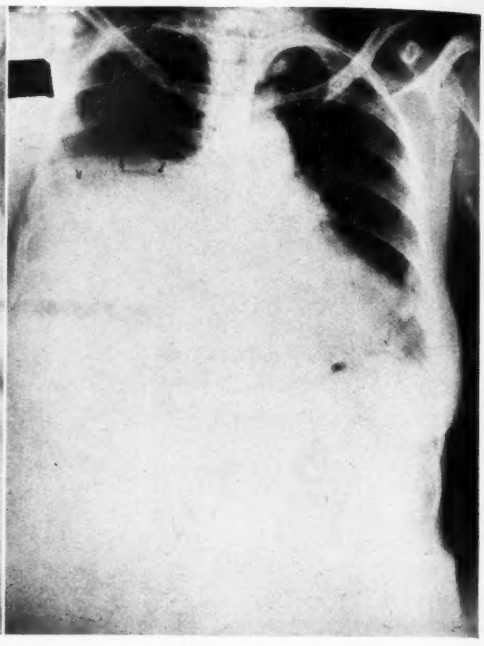

Fig. 6. Case 3. "Abnormally high position of the right dome of the diaphragm."

the right half of the diaphragm. The surgeons urged this as the roentgen evidence of a liver abscess projecting upward. We suggested the possibility of a supra-diaphragmatic structure and urged pneumoperitoneum for a diagnosis. This was done, and, as Figure 4 shows, the shadow appeared to be within the pleural cavity—either pleural effusion or a pleural tumor. The patient, however, did not get along satisfactorily and an operation was performed. Nothing was found in the sub-diaphragmatic space and the liver surface was smooth. Needling of the liver gave no results. The shadow seen in the plates was very likely above the diaphragm.

Case 3, A. W., age 28. The patient complained of pain in the right upper quadrant of the abdomen, and chills. Clinical examination led to a diagnosis of pleural effusion. Fluoroscopic examination failed to differentiate the right half of the diaphragm from the shadow of the moderate amount of fluid in the right pleural cavity (see Fig. 5). It was urged that the right half of the diaphragm might be abnormally high in position due to sub-phrenic pathology, and pneumoperitoneum was recommended. After removal of a large amount of straw-colored fluid from the chest the patient felt relieved and a pneumoperitoneum was not done. Five days later the patient was seized with severe pain and repeated chills and sweats. Fluoroscopic examination showed a large amount of fluid in the right chest and again the right half of the diaphragm could not be differentiated. This time a pneumoperitoneum was done. Figure 6 shows the abnormally high position of the right dome of the diaphragm. The findings indicated sub-phrenic pathology. An operation was performed and a large amount

of pus was removed from the right sub-diaphragmatic space.

Several dangers have been pointed out in the use of this procedure, foremost of which are the possibilities of intestinal puncture and shock. These objections, however, date back to the cases in which the entire abdomen was filled with gas. When used for the study of the sub-diaphragmatic space, only 200 c.c. need be injected, and this, in our experience, has never caused any trouble. We fully agree, however, that all methods of determining the position and excursion of the diaphragm should be undertaken before a pneumoperitoneum is done. In this connection it should be mentioned that the dome of the diaphragm may be invisible in the upright position and yet be seen in the prone position.

We wish to thank Dr. Cora Mathews for her assistance in interpreting these plates and Dr. Grey and Dr. Moeller for their assistance in reviewing the clinical histories.

SUMMARY

1. Sub-phrenic pathology very frequently causes pleural effusion.

2. This pleural effusion may obscure the position and mobility of the diaphragm and thus give rise to an erroneous diagnosis of simple pleural effusion.

3. Pneumoperitoneum, using 200 c.c. of air, is advocated as a safe method for the study of the diaphragm in questionable cases.

4. Three typical cases are presented showing the advantages of this procedure.

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A CASE OF PHARYNGEAL DIVERTICULUM OF TRAUMATIC ORIGIN

By D. DUDLEY KRUPP, M.D., FLINT, MICHIGAN

Mr. X, age 46, was hit by a baseball on the right anterior surface of the neck thirteen years ago. Swelling of the neck immediately took place, causing an enlargement. The usual local applications were employed with the hope that the swelling would subside in due time. However, this did not occur, but the patient refused to have any further medical attention given to him. For the first few weeks, he could take only liquid nourishment, but after the swelling had showed a slight amount of reduction he was able to eat semi-solid food, and this has been the condition for thirteen years. Because of fear that a surgical operation might be necessary, the man has refused to seek

Fig. 1. Roentgenogram (lateral view) of the tumor mass area, showing flocculent areas of the organized hematoma.

relief and has been content to live in that way all these intervening years.

Recently, because of a cardiac condition, he was forced to seek medical attention and the attending physician noticed a tumor mass on his neck. Upon questioning, the patient admitted that he could hear a gurgling in his throat when he took liquids, that he could not eat solid foods, and also that he could taste food several days after he had partaken of it. The writer was called in for consultation in order to determine what the X-ray would reveal; hence the report on this case for publication.

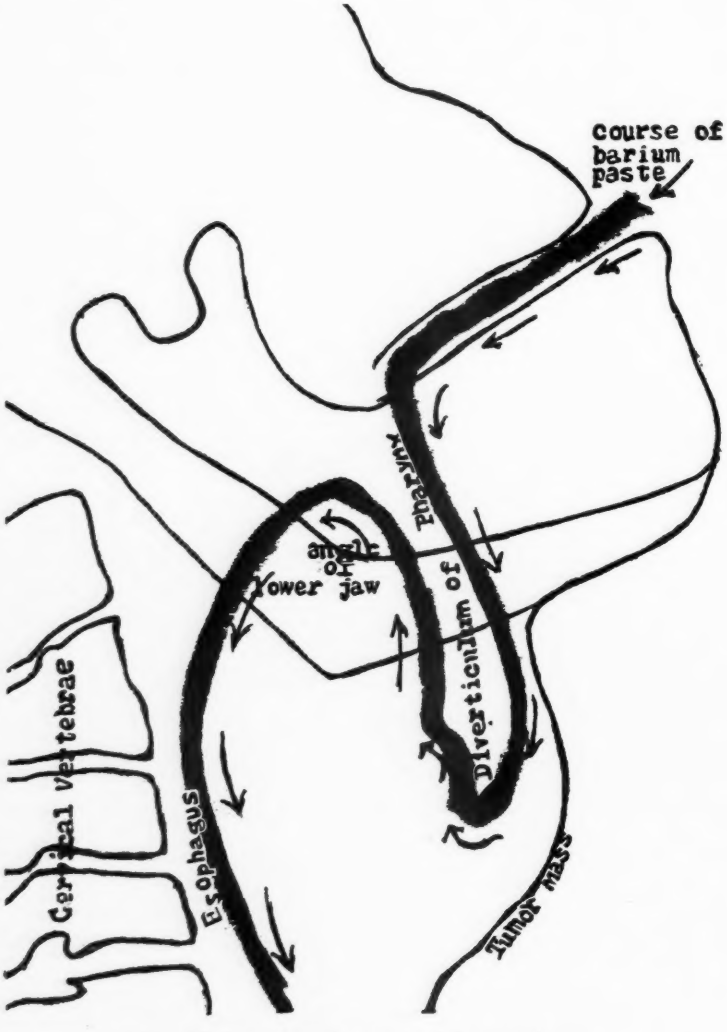

Fig. 2. Diagrammatic sketch of fluoroscopic examination. Arrows indicate course of barium paste.

Figure 1 shows the right lateral view. The abnormal contour of the neck is noted and the tumor mass is seen to be filled with a minute flaky infiltration. This I attributed

to the calcification and organization of the hematoma produced by the blow from the baseball. Upon giving the patient a heavy barium paste to drink and watching its course under the fluoroscope, it was definitely seen to go down into the tumor mass of the neck for about two inches and to back up again into the esophagus and thence into the stomach. No reverse peristalsis was noted from the esophagus. It was with great difficulty that the patient emptied the barium from the U-shaped diverticulum; in fact, at one time it so gagged him to empty the barium from the diverticulum that we became worried because of his bad heart. Another roentgenogram was immediately made, this time giving a few spoonfuls of thicker barium paste, the course of which was outlined on this film as seen in Figure 3. Figure 2 is a diagrammatic drawing from fluoroscopic observation of the course pursued by this barium paste.

Fig. 3. Roentgenogram (lateral view) with a heavy barium paste outlining the course.

Due to the poor physical and cardiac condition of the patient, operation is inadvisable. He will probably go on living under the same conditions as during the past thirteen years.

This type of case being a rarity, no case like it being found in the literature, I take this opportunity to report it as probably the first of its kind on record.

AN ACCESSORY PROTECTIVE MEASURE IN FILM STORAGE

By R. H. LOWRY, Major M.C.
Station Hospital, Fort Sam Houston, Texas

In view of the repeated occurrences of fires of undetermined origin in X-ray laboratories and other places of storage of combustible films, it has been deemed advisable to install at this clinic the following additional precautionary measure, which is presented herewith for what it is worth, where applicable.

As soon as possible after being dried, each film is read and reported in duplicate. The original copy of the report is forwarded to the clinic or physician concerned, and the carbon copy is retained in the X-ray Record Office and constitutes a permanent record of the case. The film itself is placed in the "Current File," which consists of files of three-drawer, multiple-removable compartment, all-metal filing cabinets, which are located in the reading room of the laboratory alongside of the view boxes, wherein the films are readily available for study or discussion with the members of the hospital staff as long as the patient remains in the hospital.

Those films which are no longer necessary, such as those presenting negative findings or films of patients who are no longer in the hospital, are eliminated from the files and scrapped. Examples of rare pathology or other unusual interest are stamped "Save" at the time they are read, and re-

Fig. 1. Hook-up for a series of metal filing cabinets.

tained permanently in a portion of the file set aside for this purpose.

The floor of the X-ray Department is covered with a composition cork material which is a poor conductor of electricity, with the result that the filing cabinets and contents are effectively insulated. Given these conditions, plus the presence of closely packed laminations of X-ray films and paper envelopes, it is conceivable that through removing and replacing films, and due to the unequal coefficients of expansion accompanying changes in room temperature, humidity, and atmospheric pressure, static electricity may be generated, accumulating gradually to the point where the stress is sufficient to break down the intervening dielectic and a spark may occur, which may be all that is necessary to set off the highly inflammable mass of films and paper. A situation thus exists quite comparable to the problem of transporting gasoline in rubber-tired motorized gasoline tanks, in which case the danger from static accumulation and discharge is avoided by dragging a chain connected to the truck along the ground. The same principle is applied in this laboratory. The first filing cabinet is grounded by means of a copper wire leading from it to a nearby water pipe. It is also connected with Cabinet Number 2 by means of a wire; Number 2 with Number 3, etc., by means of metal wires. Small holes are bored at the sides of the cabinets in such relationship to each other as to permit a loop of wire to pass through the contiguous sides of the two cabinets to be joined, as illustrated in the accompanying diagram (Fig. 1).

It is admitted that these premises and results are purely hypothetical. It is believed, however, that they are capable of demonstration in an adequately equipped physical laboratory.

EDITORIAL

M. J. HUBENY, M.D. . . . . *Editor*

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JOHN D. CAMP, M.D. } *Associate Editors*

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WHOLESOME CO-OPERATION

The American College of Surgeons has recently undertaken a movement which has a significant bearing upon the future progress of radiology in its relation to the treatment of cancer. For the first time in our history this subject will be taken up seriously by a group of men whom we may well consider leaders in scientific medicine, and it is not too much to hope that in the very near future they will assist us to place the proper valuation upon the rôle which radiation therapy essays in the field of therapeutic endeavor. Such a move is of tremendous importance, not alone to us radiologists but, most of all, to that vast clientele of human beings who rightfully look to the medical profession for relief from the most terrible and relentless enemy of mankind—cancer.

It is a well known fact that the number of hospital treatment centers where radiation therapy is adequately available is extremely small, and consequently reliable radiation statistics are in no manner comparable with those of surgery. Now, however, if the writer's information is reliable, the American College of Surgeons proposes to enhance the opportunity for improvement of the radiological departments of the hospitals by concentration of cancer cases, consultation with special staff groups, stimulation of research, and by making available the methods and results of standard group practices in other institutions. To this end cancer committees or cancer clinics will be encouraged in such institutions, where the radiologist will be given equal opportunity with the surgeon to study out the proper procedure for the diagnosis and treatment plan of the individual patient. The writer feels that this is the most portentous movement inaugurated in recent years, and he believes that every earnest radiologist will gladly seize upon this opportunity and do his utmost to co-operate in this altruistic work.

To single out one field where surgery and radiology must soon reach an understanding, cancer of the breast is suggested as the one which offers the most debatable ground. The operative treatment of cancer of the breast has now been practically standardized; that is, it is generally recognized that anything short of total extirpation, with a clean dissection of all accessible lymphatic structures, is useless. Has radiation treatment for the same condition been equally standardized? By no means. Radiologists are not at all in accord as to what constitutes a total sterilization dose or a total cancer dose, neither have they agreed as to what constitutes an ideal X-ray procedure even with the available measurable factors, such as voltage, milliamperage, distance, filter, time, etc., nor has it been possible as yet with radium to accept a standard known to be sufficient, accurate, and ideal. It may be said in defense, and with justice, that surgery is comparatively a straight mechanical procedure which is attainable by all good surgeons, while radiation is a complex study involving electricity, physics, biochemistry, and mathematics, and that the science is so recent that it has so far been impossible to correlate all the information obtained into a simple standard available to all good radi-

ologists, in the same proportion as has already been achieved in surgery.

It is, therefore, important that radiologists acquire as soon as possible an acceptable working standard which will insure for each patient an effective cancer dose. What constitutes such a dose has, in the writer's opinion, not yet been satisfactorily established.

ALBERT SOILAND, M.D.

REPORT OF THE PUBLICITY AND EDUCATIONAL COMMITTEE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA FOR THE YEAR 1929

Having no established precedent for this work in our organization, it was necessary to first cast about and gather information relative to what other organizations were doing along this line. We found much to support the reason for and value of the work of our Committee.

The Committee decided to devote itself (1) to publicity, and (2) to educational work. We, the members of the Committee, proposed to limit our publicity work entirely to the dissemination of material to the other medical organizations of the United States and Canada, and through these organizations to reach the individual physicians.

Our work under this heading includes:

(1) The preparation of an outline covering the functions of the local publicity committee at the place where our Annual Meeting was to be held—in this case, Toronto, Ontario. A copy of this outline is attached as a separate memorandum to this report.

(2) Each counselor of the Society was requested to see that an announcement carrying full publicity was run in every medical periodical in his district. The counselors all co-operated very well in this movement; copies of letters from various counselors are attached separately to this report.

(3) Announcements covering our meeting were sent to the *Journal of the American Medical Association, The Illinois Medical Journal,* and the *Bulletin of the Chicago Medical Society.*

(4) Letters were written to the local publicity committee, Toronto, informing its members of the work of the National Publicity Committee and offering to co-operate with the local publicity committee in every way.

The above includes the work of the publicity activities of our Committee.

It was decided early in the work that it would be useless to attempt to carry out newspaper and press releases of our work without a contact established through a publicity man, who would work as a paid man, representing the Educational Committee of the Society. We engaged the services of a publicity man, Mr. Dick Smith, located in Chicago, Illinois. Mr. Smith devotes his entire time to publicity work for various enterprises and organizations. He has worked in co-operation with representatives of the Associated Press and United News Service, together with the editors of the various local daily papers, and altogether they have given us a perfect machinery through which our educational material could be disseminated through all channels of the press in the United States and Canada.

We also have perfect machinery for the dissemination of our educational material through the periodicals and journals of the United States and Canada. While we have a perfect machine for dissemination of our educational material, the output of our machine will depend upon the amount of material we may be able to collect from the membership. The Committee feels that the membership is capable of supplying such educational material. While the Committee

can furnish the method for dissemination, it can produce only a very limited amount of such material and must depend upon the membership at large for the major part. Your Committee believes there is great value to be derived from an educational standpoint from the dissemination of such material to the public.

We decided it would be of great value to have our publicity man and also our Associated Press man present at our Toronto meeting. Our opinion as to the value of their presence has been fully justified by the invaluable work they have done and the assistance they have rendered during our meeting.

Upon our arrival at the Hotel in Toronto, a press headquarters was established in Mr. Smith's room. A typewriter was furnished by the local committee and the services of a typist and stenographer were secured. This completed our machinery for the dissemination of our material.

Preceding the meeting we procured short abstracts of such of the various papers as the Committee had selected as being of definite educational value. These short abstracts were worked up into releases for the local press at Toronto and through the Associated Press, throughout the United States and Canada, and releases by wire and mail sent to all parts of the United States and Canada. Photographs were also procured in advance and many copies made, which were released throughout the United States and Canada, together with the wire stories. A short story was sent to all the home town papers of each essayist appearing on the Toronto program. These short stories were released, together with photographs, in the cases in which the latter could be procured, at the time of the presentation of the papers on the Toronto program.

Much educational work was also carried out before the meeting, including releases of material relative to work on cancer and news relative to the work of the officers of our Society previous to the meeting, care being taken that all material was given dissemination throughout the United States and Canada.

The value of the educational work released through the newspapers is emphasized by an article appearing in the December number of *Hygeia,* in which the following statement appears:

> *"Make Use of the Newspapers.*—The health educational articles should avoid the appearance of conducting direct propaganda through the newspapers. It should be remembered, however, that newspapers do offer a chance to reach the general public. Pupils like to see their names in print; the parents naturally enjoy such distinction, and citizens enjoy news items about the school. There is no difficulty in getting newspapers to print health news. Ordinarily in the interest of accuracy it is better for material to be well organized for the newspapers rather than to allow them to collect their information from random sources."

It is our plan to continue this contact in the future in a lesser degree, with a path to the press, the aim being to keep the effort alive and the radiological information trickling through the country.

We have one recommendation to make concerning the name of the Committee—that it shall be called "The Educational Committee" and that the publicity part of its work shall be delegated to the Secretary of this Society.

We have a second recommendation, as follows:

That the work of this Committee shall be continued on a full-time basis throughout the year, and, further, that we shall be allowed the services of our publicity man throughout the year.

A further recommendation is that the Executive Committee shall authorize a budget of between $1,000 and $1,200 to carry on the work throughout the next year. This amount will take care of our educational work throughout the year and the amount of $1,200 will cover the publicity and educational expense of our 1930 Annual Meeting.

Your Committee believes this work to be of inestimable value from an educational standpoint and would further recommend that action be taken by the Executive Committee at this meeting, authorizing the continuation of the work of this Committee and of a financial outlay to the amount above named.

Your Committee further recommends that the report of the Educational Committee be published in RADIOLOGY, with the hope that the members will support—and help to contribute material to be used in—our educational campaign.

B. C. CUSHWAY, M.D., *Chairman.*

FIFTH INTERNATIONAL CONGRESS OF PHYSIOTHERAPY

LIEGE, BELGIUM, SEPTEMBER 14 TO 18, 1930

The organization of this Congress is progressing rapidly and the attention of physicians is drawn to the real union which will take place in Liege on the occasion of the International Exposition and the Centenary of Independence.

The Congress of Physical Therapy, presided over by Prof. Gunzburg and Prof. De Munter, has already received recognition by twenty foreign committees, among which the French section will be under the presidency of Prof. E. Gley, of the Academy; the Holland section under the presidency of Prof. Van Breemen, Secretary of the International League for Rheumatism; the Swiss section under the presidency of Prof. Rosselet, of the University of Lausanne, Secretary of the International Committee on Light; the Spanish section under the presidency of Du Doyen Recasens, of the Faculty of Medicine of Madrid; the section of the Grand Duchy of Luxembourg under the presidency of Dr. Schmollet Weyler; the section of Poland under the presidency of Dr. E. Faber; the Portuguese section under that of Dr. Pires de Lima de Porto; the section of the United States of America under the presidency of Dr. William Benham Snow, Editor of *Physical Therapeutics* in New York; the Brazilian section under the presidency of Dr. F. Barrozo; that of England under the presidency of Dr. Kerr Russell; the Austrian section under Prof. Strasser, of Vienna; Germany under Prof. Grober, of Jena; Hungary under Professor von Dalmady; the French Colonies in Africa under Dr. Augebaud d'Oran.

The important questions proposed are:

(*a*) Rheumatism and Physiotherapy Treatment. Papers by Prof. Gunzburg, for Belgium; Prof. Van Breemen, for Holland; Prof. Wierzejewsky, for Poland.

(*b*) Affections of the Central Nervous System and Physiotherapy. Paper by Dr. Delherm, for France.

Sections on Kinesitherapy, Electrology, Hydrology, Radiology, and Actinotherapy will treat of special questions, for the consideration of which about thirty authors were solicited on September 15, 1929.

The following sections will be organized according to the number who attend the Congress at Liege: International Committee on Rheumatism; International Committee on Light; Curie Institute, Paris; Institute of Actinology, Paris; American Physical Therapy Association; American Roentgen Ray Society; Radiological Society of North America; Physiotherapeutic Sections of Paris, Belgium, and Antwerp Societies of Radiology; Societies of Electrotherapy of France, Poland, and Belgium; French Federation of Medical States for Physical Education and Sports, and Society of Hydrology of Belgium.

Acceptances may be sent to Dr. Dubois-Thepagne, Secretary-General, 25 Louvrex Street, Liege, Belgium, with the dues of 150 Belgian francs ($5.00). This will facilitate the organization of a Congress which will be noteworthy among the sessions of 1930.

Banquet of the Radiological Society of North America, Toronto, December 3, 1929.

Banquet of the Radiological Society of North America, Toronto, December 5, 1929.

WOULD STIMULATE RADIUM PRODUCTION IN UNITED STATES

Two additional Senate bills, having to do indirectly with cancer, may come before the Senate Commerce Committee, which is investigating the feasibility of governmental aid in fighting cancer on all sectors. These two bills will have to do with the encouragement of renewed radium production in this country.

At the present time, it is charged that a Belgian monopoly holds the price of radium up to $70,000 per gram, though it can be produced there for $10,000 per gram. Bureau of Mines investigations indicate that American radium could be extracted from ores in Utah and Colorado for $22,000 per gram.

Secretary of Commerce Lamont is opposed to governmental development of the radium business, but believes that private enterprise should take advantage of its opportunity in Colorado and Utah. He says that foreign firms have recently made inquiries with a view to purchasing American ore for treatment in European plants.

"Since the radium content of most American ores is not large, success would appear to depend upon organized and well-rounded industry, involving production not only of radium but also of vanadium and uranium as joint products.

"Either the uranium or radium or both might have to remain unsold in warehouses from time to time, but it is reasonable to suppose that eventually they can be sold at profit above indicated cost of production; and if this be true, provided American deposits are as extensive as commonly supposed, the prospects for re-establishing the American radium industry are quite encouraging."

Senator Charles W. Waterman, of Colorado, plans to introduce a bill providing for a Federal survey of Colorado's deposits of radium-bearing ore.

Representative Edward T. Taylor, of Colorado, will go farther than this, and will introduce a resolution requesting the Bureau of Mines to report on the feasibility of resuming governmental experimental work in producing radium.

Both of these bills in the Senate will probably go to the Commerce Committee, where Senator Wesley Jones, Chairman of the Committee, is heading an investigation as to steps which the Government should take in helping science gain further knowledge and control of cancer. It is expected, as a result of the Senate committee's investigation, that a considerable sum of money will be made continuously available for subsidizing cancer workers in the United States Public Health Service laboratories, and also in laboratories throughout the United States. Representative Taylor believes that Government funds should be made available for experimental work, which will both reduce the cost of production of radium in this country and maintain production. Even if the Government did the producing, Representative Taylor believes it would be worth while, because radium could be used in army, navy, and veterans' hospitals. Any extra radium which the Government owned could be given to cancer clinics, such as the American Society for the Control of Cancer hopes to establish throughout the country, possibly with governmental aid or complete control, or else under municipal or state subsidy.—*Science Service.*

The Nobel prize in physics was awarded to Duc de Broglie, of Paris, for research in the fields of electricity and the roentgen ray. The award is said to be worth $46,299 this year, and the winners will receive their checks on the anniversary of the death of Alfred Nobel, founder of the awards.

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GASTRO-INTESTINAL TRACT

Massive Hemorrhage from the Gastro-intestinal Tract. L. R. Sante. Am. Jour. Roentgenol. and Rad. Ther., February, 1929, XXI, 144.

Two cases of massive hemorrhage from the gastro-intestinal tract by vomiting are described. The first case occurred in a man of 52 years who showed repeated large hemorrhages, a hemoglobin of as low as 20 per cent, and a red blood count of 1,030,000. Repeated X-ray studies showed no organic pathology except colonic diverticulum, and this was the only lesion found at subsequent postmortem study.

The other case occurred in a woman, aged 47, and consisted of a single severe hemorrhage per mouth of a quart of dark blood. X-ray study of this case failed to show any evidence of organic lesion and the patient recovered promptly and was well and without symptoms six months later.

On the basis of the experimental work of Auer, who could produce gastric hemorrhages in guinea pigs by anaphylactic reaction, Sante concludes that it is highly probable that the human being may be similarly sensitized by infection of the gall bladder, appendix, or diverticulum, with a resultant, later, localized anaphylactic reaction in the nature of a hemorrhage.

J. E. HABBE, M.D.

A Case of Congenital Hypertrophic Pyloric Stenosis in a Man Aged 72. F. D. Ackman. Can. Med. Assn. Jour., October, 1929, XXI, 423.

This is a comparatively rare condition, hence this report of a case is given in detail of history, physical examination, and autopsy findings. There was a lifelong history of stomach trouble, with colicky pain and vomiting, which became progressively worse as the man grew older. The autopsy findings were dilated stomach, with a pyloric orifice that would admit only the tip of a lead pencil. There were no scars, no ulcer, and no adhesions. The pylorus was so hard that it felt almost cartilaginous.

L. J. CARTER, M.D.

Early Diagnosis of Perforated Peptic Ulcer. Fred A. J. Geier. Am. Jour. Roentgenol. and Rad. Ther., May, 1929, XXI, 465.

A case is reported of a male patient, white, aged 37, who suffered a perforation of a gastric ulcer immediately after going to an office for examination for a stomach complaint, a condition which had existed for only a few days. Roentgenologic study was made only ten minutes after the patient's acute symptoms began, but a characteristic accumulation of gas between the right diaphragm and the liver could be demonstrated and the diagnosis of perforated ulcer was sustained at the operation performed immediately following the X-ray study.

J. E. HABBE, M.D.

A Case of Co-existing Benign Esophageal and Pyloric Stenosis. Wilfrid L. Graham and W. H. Hatfield. Can. Med. Assn. Jour., December, 1928, XIX, 696.

This case is reported on account of the rarity of an esophageal obstruction being associated with a pyloric stenosis. The symptom-complex included progressively increasing vomiting, followed by difficulty in swallowing, and marked loss of weight; also the appearance of blood in the vomitus and stools. The fluoroscope showed the Rehfuss tube, passed to aspirate the stomach contents, to be lodged 1½ inches above the diaphragm. A heavy barium paste showed the esophagus to be obstructed, the lower margin of the barium being cone-shaped, and tapering off into a very narrow shadow. The stricture, as examined by the esophagoscope, was found to be non-ulcerative, and dilated. A barium meal revealed a very atonic stomach, with pyloric stenosis. Subsequent gastro-enterostomy revealed the scar of a healed ulcer on the pyloric ring, and the stenosis to be almost complete. The etio-

logical complex in this case was, first, pyloric ulcer; second, pyloric stenosis, and third, esophageal obstruction.

L. J. CARTER, M.D.

The Value of the Opaque Meal in the Diagnosis of Diseases of the Intestinal Tract. Sir Thomas Horder. Brit. Jour. Radiol., March, 1929, II, 97.

The author emphasizes the necessity for correlation of clinical and radiological data in gastro-intestinal diseases, and reiterates the statement made four years previously in the Mackenzie Davidson Lecture that when radiology and clinical medicine are divorced, the patient will frequently suffer. The writer, a clinician himself, decries the partial, as against complete, opaque meal investigations, and states as his opinion, arrived at after extensive clinical experience, that partial investigations of the gastro-intestinal tract by the barium meal are justifiable only in cases of grave illness.

Concerning specific diseases of the gastro-intestinal tract, the author states as his opinion that enteroptosis may be well shown radiographically, but he believes faulty functioning not radiologically demonstrable—and this is of greater clinical importance than faulty position.

Appendiceal pathology may not always be clearly demonstrable, and here the writer has found less help from the opaque meal examination than almost anywhere else in the gastro-intestinal tract. (However, it would seem that he refers to the inability of the X-ray to demonstrate actual inflammation, not evidence of recent or ancient inflammations.)

The opaque meal method of study has been the chief factor in bringing about a more correct clinical conception of the frequent manifestations of symptoms in one organ, usually the stomach, when the actual pathology was located in some distant one, such as the appendix.

Papers on radiological mistakes, or "fallacies," may serve the useful purpose of showing how many of these occurrences are preventable, but such papers would themselves be mistakes if they were written with the intention of belittling a method of examination which in the short space of thirty years has revolutionized diagnosis, and has shown that many diagnostic points about which it was formerly customary to dogmatize are based on very frail grounds.

J. E. HABBE, M.D.

Ulcerative Colitis. P. H. T. Thorlakson. Can. Med. Assn. Jour., December, 1928, XIX, 656.

In the diagnosis of ulcerative colitis, the sigmoidoscope is indispensable. The X-ray assists in the diagnosis by excluding other causes of diarrhea, also helping to determine the extent of the disease. It shows hypermotility of the colon, with absence of normal haustrations—the typical pipe-stem or ribbon-like colon. A barium series and a barium enema should always be done to determine the extent of the ulcerative process, and also to determine the presence or absence of strictures, or of filling defects which might indicate malignant disease. The differential diagnosis from tuberculous colitis is made by the presence of bleeding and by the occurrence of ulceration in the sigmoid and rectum, as shown by the sigmoidoscope. Both of these conditions are usually absent in tuberculous disease.

L. J. CARTER, M.D.

A Therapeutic Attempt with Borderline Rays in Gastric Ulcer. W. Gertz. Strahlentherapie, 1929, XXXII, 489.

Bucky suggested the administration of roentgen rays of 1 Å. to 2 Å. in cases of ulcers of the stomach. The method was given a trial by the author, who treated fifty cases of gastritis, gastric and duodenal ulcer. The radiation was produced at 10 K.V., 10 ma.; 460 r (18 minutes' exposure at 10 cm. distance was considered an erythema dose). He administered three times one-third of this dose to the upper abdomen at two-day intervals; after four days, the same dose over the back. All patients were kept on the Sippy diet. The leukocyte drop, as described by Bucky, was observed in all except two cases. In these two

cases, a leukocytosis developed following the exposure. As the first sign of favorable response, the pain disappeared and the general condition improved greatly. Fifteen cases were still well one year after treatment. The author urges the trial of this method in a larger series of cases.

E. A. POHLE, M.D., PH.D.

Gastric and Duodenal Ulcer. Bernard Mooney. Can. Med. Assn. Jour., October, 1929, XXI, 387.

The author bases his observations on 1,700 gastro-intestinal X-ray examinations. The findings were: gastric ulcer, 51 cases; duodenal ulcer, 183 cases; gall-bladder disease, 243 cases. The findings of gastric or duodenal ulcer are based on the direct signs (niche, accessory pocket, and organic hour-glass contraction), and on the indirect signs (incisura, spasmodic hour-glass, six-hour retention, hyperperistalsis, and hypermotility). The X-ray report is an essential part of the evidence of gastric and duodenal ulcer, and should be considered along with the study of symptoms and clinical signs in arriving at a diagnosis.

L. J. CARTER, M.D.

The Roentgen Study of Colonic Diverticula. James T. Case. Am. Jour. Roentgenol. and Rad. Ther., March, 1929, XXI, 207.

Differentiation between diverticulitis and diverticulosis is based largely upon clinical grounds, although at times the roentgenologic appearance alone will suggest the inflammatory or non-inflammatory nature of the condition. The earliest roentgen studies stopped merely with a demonstration of the small extra-lumenal pouches and of the associated marked stasis. Later, efforts have been made to estimate the degree of pericolonic thickening, the earliest roentgenologic sign of which is a widening of the re-entering angle at the neck of the diverticulum. The writer offers a new roentgenologic sign which is of particular value in those advanced cases of sigmoid involvement in which the diverticula may fail to fill. In such cases films made after a meal by mouth, at about the time the stomach is empty, will show a displacement upward and to the right of the loops of barium-filled ileum. In those cases in which the sigmoid colon can be located by its gas content, it will be noted that the space between the gas shadows and the barium shadows of the ileum is much greater than the thickness of the normal bowel wall.

J. E. HABBE, M.D.

RESPIRATORY TRACT

Basal Tuberculosis. Kennon Dunham and V. V. Norton. Am. Jour. Roentgenol. and Rad. Ther., May, 1929, XXI, 459.

The authors report an additional series of 44 cases of basal tuberculosis, 38 of which occurred in negroes. Forty cases had positive sputum and the remaining 4 were proven by guinea pig inoculation. Basal lesions rarely undergo absorption or fibrosis but almost constantly show a pneumonic or bronchopneumonic appearance as studied roentgenologically, and early death is the rule. The majority of the cases studied at postmortem showed extra-pulmonary lesions (chiefly mesenteric or tracheobronchial adenitis and ileocolitis). The belief is expressed that the basal form of tuberculosis may be more regularly associated with extensive tuberculous lesions elsewhere in the body than the commoner apical form.

J. E. HABBE, M.D.

X-ray Therapy of Bronchial Asthma by Irradiation of the Spleen. Leopold Holst and D. Kaplunowa. Strahlentherapie, 1929, XXXII, 505.

Fifty-seven cases of bronchial asthma were treated over the spleen by roentgen rays. Technic: 165 K.V., 2 ma., 23 cm. F.S.D., 0.5 Cu. + 1.0 Al., 30 minutes. This corresponds to about 50 per cent of the erythema dose and was given over the anterior spleen only. If necessary, the dose was repeated but not before a three-weeks interval. Forty-four cases

could be analyzed in the statistics; thirty-eight of these responded well. Irradiation of the hilum is suggested if the spleen exposure is not successful.

E. A. POHLE, M.D., PH.D.

TUBERCULOSIS

Roentgen-Anatomical Studies of the Colon in Patients with Pulmonary Tuberculosis. Homer L. Sampson and Bela Halpert. Am. Jour. Roentgenol. and Rad. Ther., January, 1929, XXI, 37.

The writers present further statistics on their roentgen-anatomical findings in 300 patients suffering from pulmonary tuberculosis. All films were made with the patient in the standing position twenty-five hours after taking the barium meal, and all measurements were made in terms of the patient's own spine or pelvis. A rather striking observation is the frequency with which adhesions between adjacent loops of the colon in the region of the hepatic and splenic flexures were inferred by roentgenoscopy, 52 per cent of the cases showing adhesions about the hepatic flexure, and 36 per cent at the splenic flexure. Perfect fusion of the layers of the greater omentum, as judged by the relative position of the stomach and transverse colon, was noted in less than half the cases, the remainder being classified as cases of non-fusion, imperfect fusion, or irregular fusion.

J. E. HABBE, M.D.

CANCER

The Rôle of the Roentgen Ray in Determining the Resectability of Gastric Cancer. Alexander B. Moore. Am. Jour. Roentgenol. and Rad. Ther., March, 1929, XXI, 226.

The three factors of basic importance in determining the resectability of gastric cancer are: location of the tumor, presence or absence of fixation to surrounding structures, and presence or absence of metastases. Scirrhous cancers usually involve a somewhat greater portion of the stomach than the filling defect might lead one to believe. Fixation to surrounding structures, particularly to the pancreas, which may itself be mobile, is often impossible to determine. Metastases to the liver and lymphatics, which are common, are not demonstrable. Therefore, it is not surprising that of 204 cases coming to operation, slightly over 50 per cent showed nothing on roentgen examination to indicate that they were inoperable, as exploration proved them to be. On the other hand, of 196 successfully resected, 179 (or 91 per cent) were considered operable from their roentgen findings. Again, in only 10 per cent of the entire series of 400 cases were cases operated on despite a roentgenologic report of "inoperable."

J. E. HABBE, M.D.

Roentgen Treatment of Carcinoma of the Tonsils. H. Coutard. Strahlentherapie, 1929, XXXIII, 249.

During the period from 1920 to 1926, forty-six cases of carcinoma of the tonsils were treated by roentgen rays, at the Radium Institute in Paris. Most of the patients arrived in a rather advanced stage, because this type of tumor, as a rule, does not cause much pain. Many seek advice because of the swelling of the glands of the neck due to metastasis. Thirty-four of the patients died or will die, in all probability, in the near future. Twelve patients are living and now free of carcinoma. The interval between the treatments is at least 18 months and in the case of the oldest patient 6 to 7 years. Three of these twelve cured patients received radium in addition to roentgen rays. In one case, a small metastatic lymph gland was removed by surgery; four were suffering from large inoperable glandular metastases; five had little definite involvement, and three were free of palpable glands. In nine cases, the lesion in the tonsil was very extensive, while three patients came in the early stage of the disease. Biopsy had been carried out in all cases.

With the exception of the year 1921, the

technic for the roentgen treatment was as follows: 180 K.V., 1.5 mm. to 2.0 mm. Zn., 40 cm. to 50 cm. F.S.D., 100 cm. by 250 cm. field, dose 50 to 150 H, corresponding to 12,500 to 37,500 French R (Solomon).

The dryness of the mouth and the perversion of the sense of taste are sometimes most annoying. The erythema which appears both on the skin and on the mucous membrane has to be watched carefully. Extraction of the teeth is contra-indicated, because this may be followed by osteonecrosis even four and a half years after the last treatment.

E. A. POHLE, M.D.

Two Cases of Cancer of the Lung. By the Medical Staff of the Mountain Sanatorium, Hamilton, Ont. Can. Med. Assn. Jour., December, 1928, XIX, 698.

Two cases of cancer of the lung are contrasted. One occurred in the left lung, was of alveogenic origin, was emaciating, and ran a rapidly fatal course. The other occurred in the right lung, was of bronchogenic origin, ran a very slow course (of six years), showed no emaciation, and was symptomless except for the continual occurrence of large hemorrhages, which eventually proved fatal.

The first case was characterized pathologically by large serosanguineous pleural and pericardial effusions; the second case by spontaneous pneumothorax, atelectasis, and bronchiectasis distal to the tumor.

L. J. CARTER, M.D.

Inoperable Carcinomia of the Breast Treated with Radium. Roy Ward. Brit. Med. Jour., Feb. 9, 1929, p. 242.

In summarizing the results of radium treatment at the Radium Institute, London, during the last ten years, it was found that 22 per cent of patients were alive at the end of three years, 12.6 per cent at the end of five years, and 6.1 per cent at the end of ten years. A review of the cases treated during the last three years promises to show more favorable results, due to advances in technic and to the fact that the patients are being seen at an earlier stage of the disease.

Cases may be classified in three groups: early operable, late operable, and inoperable.

Early Operable.—In cases of this class it has yet to be shown that radium treatment can give as good results as operation, but much may be accomplished by using radium as an adjunct to surgery.

Late Operable.—Few are cured by surgery alone and in this and the inoperable class patients are often greatly benefited by radium treatment. Factors in the treatment are the amount of radium required, the intensity of the dose and the filtration, and the time of exposure. Scirrhous growths require needles of low content heavily screened and left *in situ* for a comparatively long time—about a week. When an ulcer exists the needles should be introduced into the healthy tissue in the immediate vicinity of the growth. Isolated subcutaneous nodules are best treated with platinum or gold seeds containing radon.

Rapidly growing tumors are more susceptible to irradiation, and respond more dramatically than the scirrhous growths. They require a large dose for a comparatively short time—three or four days—and the needles need not be so heavily screened.

Mr. Sampson Handley believes that breast cancer, when it comes to operation, is already an intrathoracic disease, and the rational treatment seems to be to irradiate the chest more thoroughly, with special attention to the lymphatic areas. The first treatment should always be as thorough and vigorous as possible as there is no doubt but that recurrences appearing after prophylactic irradiation are highly refractory to further irradiation.

H. W. DUNDAS MACKENZIE, M.D.

Radiosensitive Epidermoid Carcinomas. James Ewing. Am. Jour. Roentgenol. and Rad. Ther., April, 1929, XXI, 313.

In treating epidermoid carcinomas it is essential that both surgeon and radiotherapist have some knowledge concerning each case as regards its potential malignancy and degree of radiosensitivity. While these two tumor char-

acteristics often run parallel, they do not do so constantly, relatively benign basal-cell carcinomas being very radiosensitive and highly malignant melanomas being quite resistant. Radiosensitivity depends upon metabolic rate of tumor cells, desmoplastic property of tumor, vascularity, location, and origin of tumor cells. Radiosensitive epidermoid carcinomas, which give poor results by surgery alone, may often be controlled either by surgery in conjunction with irradiation or by irradiation alone.

J. E. HABBE, M.D.

Carcinoma and Acid Base Equilibrium. H. Th. Schreus. Strahlentherapie, 1929, XXXIII, 243.

The hydrogen-ion concentration in carcinoma cases was found to be higher than in normal individuals. The regularity of this observation permits the conclusion that a PH above 7.42 is almost a diagnostic factor in carcinoma. It is also important in view of the treatment of carcinoma by oxygen-carbon dioxide inhalations, as suggested by B. Fischer-Wasels. The percentage of carbon dioxide in this mixture amounts to from 4 to 5 per cent and is higher than the carbon dioxide tension in the alveoli of the lung. The author compared the hydrogen-ion concentration of carcinoma patients before and after inhalation of an air-carbon dioxide mixture (4.5 per cent carbon dioxide) and found the PH average of 7.448 before and 7.372 after the inhalation. This is a shifting toward the normal rate, a fact which should encourage the use of the inhalation method in carcinoma.

E. A. POHLE, M.D.

Report of Cases Treated with Injections of Cancisal and Anabol. K. F. Vorlaender. Strahlentherapie, 1929, XXXIII, 221.

Opitz, the late Director of the Women's Clinic in Freiburg, has developed a number of chemical preparations for the treatment of cancer. One, "Cancisal 919," contains cholin and adrenalin, while the second consists of certain organic acids and is called "Anabol." In this paper, preliminary results in a limited number of treated cases are discussed by one of his assistants. Although no false hope must be raised, due to some favorable effects observed occasionally, credit is due to Opitz, who has opened a new territory in the combat against carcinoma.

E. A. POHLE, M.D.

The Intensive Treatment of Carcinoma of the Breast. F. Nahmmacher. Strahlentherapie, 1928, XXX, 490.

It is suggested to give intensive X-ray therapy to the entire diseased breast, including axilla, supra- and infra-clavicular regions, followed fourteen days later by radical removal of the breast, including the skin, the wound to be covered by transplantation. Four weeks following the operation, the axilla, supra- and infra-clavicular regions, and the parasternal field are treated by radium. This radium treatment is sometimes repeated in from four to five weeks. The author requests that this radical method be given a trial.

E. A. POHLE, M.D., PH.D.

Results in Tabular Form of Radiation Therapy of Uterine Carcinoma. A. Döderlein. Strahlentherapie, 1929, XXXIII, 89.

On two pages, Döderlein, the head of the Women's Clinic at the University of Munich, presents a number of tables without text, comparing the end-results of surgical and radiation treatment in cancer of the cervix, uterus, vulva, and vagina. "These figures speak louder than long sentences." Every physician interested in the treatment of cancer will find it worth while to look up the original.

E. A. POHLE, M.D., PH.D.

Thirteen Years' Radiation Therapy of Uterine Carcinoma. G. Gambarow. Strahlentherapie, 1928, XXX, 467.

One hundred cases of inoperable carcinoma of the uterus were treated during the years 1920 to 1923. Six patients (5.7 per cent) were free of recurrence after five years. Fifty

milligrams of radium element were introduced into the uterus in Dominici tubes. This was repeated from five to seven times, in intervals of one to six days, making a total dose of 3,000 to 4,900 mgh.

E. A. POHLE, M.D., PH.D.

Surprising Improvement Following Small Doses of Roentgen Rays in Hopeless Cases of Uterine Carcinoma. Felix Gál. Strahlentherapie, 1928, XXXI, 91.

The author reports three cases of far advanced carcinoma of the uterus that received X-ray deep therapy every four weeks; two abdominal and two sacral fields of 50 per cent E.D. were given (27 cm. spark gap, 1 mm. zinc). The cases all responded so well that he feels justified in publishing their histories and in recommending his therapeutic procedure.

E. A. POHLE, M.D., PH.D.

The Permanent Cure of Uterine Carcinoma Following Radium and Combined Roentgen Therapy. W. Lahm. Strahlentherapie, 1928, XXX, 471.

The author analyzed 109 cases of carcinoma of the cervix which had been cured for over a period of five years. The best results were obtained if the total dose had been given within three to five weeks. In case of radium treatment alone, 6,000 to 10,000 milligram-hours, and in case of combined therapy 5,000 to 7,000 milligram-hours in addition to from 400 to 1000 R effective in the cervix were most satisfactory. The inhomogeneity of the radiated area is also often improved.

E. A. POHLE, M.D., PH.D.

Radiation Therapy of Carcinoma of the Cervix. Paul Strassmann. Strahlentherapie, 1929, XXXII, 413.

In this paper, which was presented before the International Congress on Radiology, the author analyzed the results of radiation therapy in the cases of uterine carcinoma observed in his clinic since 1913. Only those treated between 1913 and 1923 were used for his statistical study. Out of a total of 429 patients, 358 could be followed up: 31 per cent were operable, 57 per cent inoperable, while the remainder could not be traced. He obtained a 30 per cent cure in the operable cases and a 17.4 per cent cure in the borderline and inoperable cases. Nearly all patients had passed the five-year period. He concludes that at present the combined X-ray and radium treatment of carcinoma of the cervix will be given the preference in his clinic. The details of the very interesting statistics should be looked up in the original.

E. A. POHLE, M.D., PH.D.

ROENTGEN THERAPY

Irradiation in Myeloid Leukemia, with Massive Splenomegaly. W. T. Cummins. Calif. and Western Med., May, 1929, XXX, 347.

Dr. Cummins reports the case of a Portuguese, male, age 43, painter, who was admitted to the hospital February 28, 1925. At that time the leukocyte count was 320,000, with myelocytes 13 per cent. The basal metabolism was plus 54 per cent. This fell to plus 28 per cent after two X-ray treatments to spleen, thighs, and legs. Diagnosis: myeloid leukemia. The patient was discharged, improved, on April 10, 1925. Over a period of fifteen days, with four X-ray treatments to the spleen, thighs, and legs, the leukocytes were reduced to 5,800, and the myelocytes to 3 per cent.

The man returned March 3, 1926, with a leukocyte count of 87,000, and myelocytes 14 per cent. During a period of twenty-one days the patient received six X-ray treatments, the leukocytes being again reduced to 8,000 and the myelocytes to 3 per cent. December 2, 1926, the leukocytes were 194,000 and myelocytes 8 per cent. During the next eight months the leukocyte count ranged from 134,000 to 246,000, and myelocytes from 8 to 11 per cent. In July, 1927, the patient was again admitted to the hospital. During a period of

six weeks he received twenty-seven X-ray treatments to the ribs, sternum, forearms, thighs, and legs. On September 15, 1927, the leukocytes were 8,700. November 6, 1927, he had an attack of dyspnea and five days later returned to the hospital. Leukocytes were then 119,000. Fifteen X-ray treatments were given in seven weeks' time. Leukocytes were again down to 30,000 but again began to rise.

The patient died January 15, 1928. A total of 52 X-ray treatments in four series had been given. The autopsy findings are recorded. The spleen was of unusual size, weighing 10,110 grams and measuring $42 \times 27 \times 15$ centimeters.

FRANCIS B. SHELDON, M.D.

Disturbance in Growth Following Roentgen Therapy. A. Beck. Strahlentherapie, 1929, XXXII, 517.

Retardation in growth following X-ray exposure has been observed by a number of clinicians. In this article, the histories of seven cases of knee, ankle, and wrist tuberculosis are related, in which a considerable inhibition in growth resulted following X-ray treatment. While it is quite possible that the disease itself as well as the long periods of inactivity (extremities in cast) may be responsible for part of the noted changes, caution is indicated in prescribing the dose.

E. A. POHLE, M.D., PH.D.

Our Experience with the Irradiation of the Ovaries with Small Doses of Roentgen Rays. M. Bolaffio and R. Bompiani. Strahlentherapie, 1929, XXXII, 465.

The treatment of menstrual disturbances with small doses of roentgen rays to the ovaries has been tried by the authors in 44 cases. They used a radiation of 165 to 170 K.V., 0.7 Zn. filter, 30 cm. F.S.D., 20 cm. $\times$ 12 cm. field. Twenty-five per cent of the H.E.D. was delivered in one sitting, or a total of one-third E.D. in two sittings, within five to seven days. Twenty-seven cases were classed as primary because the disturbance had been present since puberty without any pathological findings, also five of six cases accompanied by tuberculosis. In 12 patients the symptoms developed later; usually the cause was unknown. Eighteen patients were cured by the treatment, 6 were improved, and in 20 cases there was no response. The probable mechanism of the effect, the prognosis, and the possible injury to a future pregnancy, are discussed. The authors emphasize that caution is essential in the prescription of the dose, the treatment being given only according to strict indications.

E. A. POHLE, M.D., PH.D.

On the Indications for X-ray Treatment of Malignant Tumors as Compared with Other Methods of Treatment (Radium, Surgery, Medical Treatment). R. Werner. Strahlentherapie, 1928, XXX, 1.

The author discusses the indications for roentgen-ray therapy in malignancy, based on his wide experience of over twenty years. While this article does not lend itself to abstracting, its study in the original is recommended.

E. A. POHLE, M.D., PH.D.

Regarding the X-ray Treatment of Brain Tumors. A. Störmer and P. P. Gotthardt. Strahlentherapie, 1928, XXIX, 678.

In the authors' opinion, the glioma which is rich in cells represents the most favorable object for irradiation. Other types, as well as fibroma, neuroma, and endothelioma, do not respond well. In 34 cases, 29 per cent were improved, coming close to a cure; in 20 per cent a permanent improvement was obtained; in the remaining cases only temporary improvement was seen or they showed no response at all. The tumors of the cerebellum seem to be more favorable than others. Operable tumors should be operated upon; a series of treatments is permissible before operation in the absence of pressure symptoms. All inoperable tumors should receive irradiation. It seems that the results of irradiation are no worse than those following surgery. As a

rule, four or five fields are used in order to get about 100 per cent S.U.D. in the tumor; deep therapy radiation has been employed.

E. A. POHLE, M.D., PH.D.

Is It Possible and Desirable to Induce Permanent Amenorrhea with Graded Doses of Roentgen Rays? H. Weigand. Strahlentherapie, 1928, XXX, 497.

Ever since the publications of Seitz and Wintz regarding sterilization by roentgen rays, a standard dose (35 per cent E.D. to the ovaries) has been used in most clinics. The author contends that it is possible to obtain the same results with graded doses. In a number of cases, a lower dose will induce permanent amenorrhea. This reduces the incidence of X-ray sickness and also the symptoms following sterilization.

E. A. POHLE, M.D., PH.D.

Multiple Disseminated Sclerosis. K. W. Ipatoff and A. A. Romanowa-Leskowa. Strahlentherapie, 1928, XXXI, 164.

The roentgen therapy of multiple disseminated sclerosis is recommended as the method of choice. Sometimes results do not manifest themselves before several months, or even years, following treatment. A single dose of 25 per cent E.D. of filtered radiation through 4 mm. aluminum must not be exceeded; it is best to radiate the entire brain in order to prevent missing any diseased area.

E. A. POHLE, M.D., PH.D.

X-ray Therapy of Tumors of the Brain. E. H. Michalowsky. Strahlentherapie, 1928, XXX, 644.

In view of the unsatisfactory results of surgery in brain tumor cases, the author states that in each case radiation should be given a trial. Of 24 patients (four hypophyseal tumors), 60 per cent showed definite improvement, 15 per cent were temporarily improved, and 25 per cent did not respond at all. Two patients were clinically cured. Some of the favorable cases did not return for further treatment. Of the four hypophyseal tumors, one did not respond, two showed temporary relief, and one was definitely improved.

E. A. POHLE, M.D., PH.D.

Regarding Pathology of the Effect of Radiation on Carcinoma. J. Wätjen. Strahlentherapie, 1928, XXIX, 615.

This is an interesting description of the histological changes in carcinoma following irradiation. While it does not lend itself to abstracting, it is recommended for study in the original. The author emphasizes that although the pathologist is more-or-less skeptical regarding the histological proof of curative changes in tumors following irradiation, this must not delay the progress in radiation therapy. As a matter of fact, it should help to differentiate the chaff from the wheat.

E. A. POHLE, M.D., PH.D.

X-ray Therapy of Chronic Arthritis. Kurt Käding. Strahlentherapie, 1928, XXXI, 135.

The author recommends roentgen therapy as a valuable agent in treatment of chronic arthritis. He usually gives 15 to 30 per cent E.D., 150 K.V., 4 ma. through 5 mm. Al. or 0.5 Cu. + 1.0 Al., at a distance of from 27 cm. to 35 cm. The treatment is given at intervals of three days, from two or three sides, according to the size of the joint and thickness of the muscle and fat layer. This is combined with physical therapy, as, for instance, hydrotherapy, massage, or diathermy. The whole series is repeated after four, six, or eight weeks. In cases in which the arthritis is probably due to some inner secretory disturbance, the ovaries or hypophysis may be exposed.

E. A. POHLE, M.D., PH.D.

Dependence of Roentgen-ray Sensitivity upon the Age of the Cell: Observations on Epilation. H. Holthusen. Strahlentherapie, 1928, XXXI, 5.

The author reports five observations made on three patients where the same dose which

led to complete epilation on untreated areas of the skull did not inhibit the growth of new hair in the same areas two or three months following the epilation dose. He believes this phenomenon to be due to a lessened sensitivity of the new hair follicles. A similar decrease of sensitivity can be observed if the epilation dose is applied under compression. This is an arrangement which renders the treated area anemic.

E. A. POHLE, M.D., PH.D.

Somnolence as Result of Irradiation of the Head. Adolf Druckmann. Strahlentherapie, 1929, XXXIII, 382.

Thirty cases out of 11,000 children treated over the skull for trichophytosis with roentgen rays (150 K.V., 0.5 Al., 6 H per field) developed somnolence six to eight weeks after the exposure. Some children complained of headache, lack of appetite, and also of constipation. A slight temperature (up to 38.5 degrees centigrade) was observed occasionally. In light attacks, the symptoms disappeared within five to six days; the more severe cases lasted about two weeks. After reduction of the potential to 70 K.V. and, therefore, a decrease of the penetration of the radiation, these effects of the roentgen treatment did not occur. The author believes that the symptoms observed were due to the influence of penetrating roentgen rays on the brain. The children were followed up for four years. No permanent injurious effect has been observed so far.

E. A. POHLE, M.D.

X-ray Therapy of Tuberculosis of Joints through Plaster-of-Paris Cast. H. von Spindler. Strahlentherapie, 1928, XXIX, 806.

The author reports the results of measurements carried out on plaster-of-Paris of different thicknesses. In order to find out the corrective factor for treating a patient through a cast, he found that so many variable factors enter into such a calculation that it is not advisable to give treatments through a plaster-of-Paris cast.

E. A. POHLE, M.D., PH.D.

X-ray Therapy of Inflammatory Complications of Scarlet Fever. F. Bardachzi. Strahlentherapie, 1928, XXVIII, 805.

Some complications of scarlet fever, namely, cervical lymphadenitis, mastoiditis, and ethmoiditis, were treated with small doses of roentgen rays. In a certain number of cases there seemed to be a beneficial effect. It is, therefore, suggested that the method be given a trial.

E. A. POHLE, M.D.

X-ray Therapy of Hay-fever. Adolf and Lilly Pokorny. Strahlentherapie, 1928, XXVIII, 808.

Two cases of hay-fever of long standing are reported in this article. They received X-ray therapy: 120 K.V., 4.0 Al., 25 cm. F.S.D., 6 $\times$ 6 cm. field of entry, 4 H over the nose. The results were excellent, and the authors ask, therefore, that this method be given a trial.

E. A. POHLE, M.D.

MEASUREMENT OF RADIATION

A Comparison of Practical Methods of Measuring Roentgen-ray Quality for Therapy. Edith H. Quimby. Am. Jour. Roentgenol. and Rad. Ther., January, 1929, XXI, 64.

Three measurements of quality determination of roentgen rays are compared qualitatively. These are: absorption coefficients referred to 0.1 mm. of copper, half value layer in copper, and effective wave length as determined by absorption in 1.0 mm. of copper. It was found that for therapy machines of the mechanical rectifier type, the quality is sufficiently determined by a statement of voltage and filtration, but because of difficulties in exact measurement of voltage, some further

specification such as absorption coefficient referred to from 0.1 to 0.25 mm. copper, or the effective wave length as determined by absorption in such a thickness, is recommended.

J. E. HABBE, M.D.

The Standardization of Roentgenography. Paul M. Andrus. Can. Med. Assn. Jour., November, 1929, XXI, 550.

The variation in films produced in different X-ray departments calls for standardization of machinery, films, and technic. Technical methods are demanding increasingly large currents in the tube circuit. This requires modification in the high potential transformer. These large currents require delicate control—a control which involves three factors: means of control, measurement of control, and stabilization. More accurate control requires multiple-step autotransformers, with steps not greater than one kilovolt.

Measurement of voltage may be made on the primary or the high tension transformer, or in the Coolidge circuit, but a method of making a film-effect determination would be the most accurate standardization procedure. This, however, is possibly not an accomplishment of the near future.

Stabilization of the entire electrical unit by line control is a development which may be expected.

The control of current on the high tension circuit for purposes of modern technic would be facilitated by having Coolidge ammeters and transformers up to six amperes capacity instead of five. The ammeters should be spread over as large a dial as possible, that minute changes on this high voltage may be read with exactitude.

Standardization of films is satisfactory as to uniformity, but greater speed is desirable.

X-ray tubes leave much to be desired in uniformity and durability. Roentgenologists require tubes of greater capacity, greater durability, and greater uniformity.

Accessories for the control of scattered radiation require improvement. A faster Bucky grid is needed, with air space, instead of wood space, between the metal strips.

The best target-skin distance should be worked out. It is a simple mathematical procedure to determine at what distance a focal spot of given size must be placed, to radiograph an object of known size at a known film distance.

The time of exposure is determined by one's ability to immobilize the part. Whether, as in the case of lung radiographs, one should synchronize the time of exposure with the vascular phase, is not yet settled.

Timers, for split-second work, should deal in wave peaks rather than in elapsed time, otherwise there may be an error as large as 50 per cent.

Density and contrast in films are too much a matter of personal opinion. Future X-ray studies will require a series of films, varying densities and contrasts, to bring out all the details of the tissue radiated.

In the matter of education, the roentgenologist of to-morrow must be a physicist and a technician. This can be accomplished only by our North American universities providing detailed courses and diplomas in the physics and applications of the roentgen ray.

L. J. CARTER, M.D.

The Accuracy of the Absolute Determination of the Roentgen Unit with the Thimble and the Barrel Ionization Chambers. R. Braun and H. Kuestner. Strahlentherapie, 1929, XXXIII, 273.

This is the third communication in a series of articles dealing with the physics of the thimble ionization chamber (see *Strahlentherapie*, 1929, XXXII, 550, and XXXII, 739). The tables, curves, and mathematical deductions must be looked up in the original.

E. A. POHLE, M.D.

On Dosimetry in Radium and Combined Radium and Roentgen Treatment. Th. C. Neeff. Strahlentherapie, 1929, XXXIII, 253.

Skin tests established 430 milligram-hours as equivalent to an erythema dose (radium preparation 23.1 milligrams element, 2 cm.

length, filter 0.2 mm. platinum + 1.2 mm. Br. at 1 cm. distance from the skin). Measurements carried out with a special ionization chamber showed that 1 milligram-hour radium (filtered through 2.0 mm. Br.) corresponded to 2.9 r. For the determination of the dose in carcinoma of the cervix, tables are presented which also permit the calculation of the combined roentgen and radium dose. The necessity of exact measurement before treating a malignancy of the uterus is emphasized.

E. A. POHLE, M.D.

Dosage Measurements in r-units with the Standard Instrument in the Region of Superficial Therapy and Radiography. H. Hase and H. Küstner. Strahlentherapie, 1928, XXX, 86.

This is a careful investigation of the behavior of the standard instrument of Küstner in the region from 20 to 80 K.V. For the absorption measurements Zellon proved to be the material of choice. One mm. Zellon absorbs any wave length of roentgen rays, from potentials as used in radiography up to deep therapy radiation as much as 109 cm. of air. When using a large ionization chamber, the window through which the rays enter must have a certain minimum thickness, otherwise electrons emitted by the edge of the diaphragm may cause a considerable error.

E. A. POHLE, M.D., PH.D.

The Ionization Method of X-ray Measurement. J. A. Crowther. Brit. Jour. Radiol., April, 1929, II, 175.

Physicists have from the beginning used the ionization method for measuring X-radiation. However, for a final determination of the energy produced the calorimetric method must be resorted to, and this is a difficult procedure, since the energy produced by even a powerful beam of X-rays is very minute. Hence the calorimetric determination must be an experimental procedure, but can be used to advantage in standardizing ionization measurements.

It was found that the roentgen (r) does not measure directly the energy of the beam, for rays of shorter wave length but of equal energy gave a smaller indication in the dosage meter. However, the roentgen was shown to be a direct measure of energy absorption in the tissues, which is, presumably, a direct measure of the biologic effect produced.

It is probable, then, that the voltage through the tube and filtration employed, expresses most conveniently the quality of the radiation.

The author recommends the selection by the Units Committee of a standard ionization chamber, against which other types of ionization chambers could be standardized.

J. E. HABBE, M.D.

Measurements with the Sphere Gap. W. Schmitz and O. Rienhoff. Strahlentherapie, 1929, XXXII, 582.

A number of precautions necessary when measuring potentials with a sphere gap are discussed in this paper. The amount of resistance in series with the gap does not influence results when direct current is measured; for pulsating direct current, it should not exceed 30 megohms. For the recording of potentials of sinusoidal alternating current, a correction factor is usually necessary. Tables and curves illustrate these observations.

E. A. POHLE, M.D., PH.D.

A Direct-reading Static Voltmeter for High Potentials. H. Starke and R. Schroeder. Strahlentherapie, 1928, XXIX, 798.

This is a description of a static voltmeter reading potentials from 2 to 700 K.V. One model is made in portable form and can be used in roentgenology for readings on direct or alternating current.

E. A. POHLE, M.D., PH.D.

The Physics of the Thimble Ionization Chamber. R. Braun and H. Küstner. Strahlentherapie, 1929, XXXII, 550.

The authors have undertaken an extensive study of the thimble ionization chamber, its advantages and disadvantages. They submit a number of suggestions which have to be ob-

served in order to avoid errors in the recorded measurements. Anyone interested in the use of such chambers and who wishes to attempt the construction of the instrument should read this article in the original.

E. A. POHLE, M.D., PH.D.

EXPERIMENTAL STUDIES

On the Question of Changes in the Reaction of Irradiated Tissue. M. A. Magath. Strahlentherapie, 1929, XXXII, 534.

The changes in the reaction of tissues following roentgen irradiation were studied by a number of methods; they all led principally to the same results. The error due to the use of indicators was found to be negligible in these experiments. Five minutes to one hour following intensive roentgen irradiation of chicken embryos *in ovo*, the reaction of the body fluids shifts towards the acid side *intra vitam*. If single parts of such embryos are studied, the same change of reaction can be recorded in superficial soft tissues; it is missing in liver and brain. No change in the reaction could be noted in carcinoma taken from mice nor in the liver of these animals. Following vital staining with bromthymol blue, the dye disappeared more quickly in the irradiated area. This can not be explained by the change in the reaction alone.

E. A. POHLE, M.D., PH.D.

The Influence of Roentgen Rays on the Diffusion and the Permeability of the Cell Membrane. K. Kovács. Strahlentherapie, 1928, XXX, 77.

The influence of roentgen rays on the permeability of cell membranes was studied on the surviving hearts of frogs. Relatively high doses had to be used because of the well known high resistance of frogs to radiation. It appears that the permeability of the cell membrane was considerably increased following exposure to roentgen rays of about 6 E.D. (168 K.V., 4 ma., 0.5 Al., 20 cm. F.D.).

E. A. POHLE, M.D., PH.D.

RADIUM

Radium and Its Action. W. E. Dixon. Brit. Med. Jour., Feb. 9, 1929, p. 238.

The radio-active metals are uranium, thorium, polonium, and radium. Radium salts are the most radio-active. The only practical application of radium at the present time is in medicine. The total amount of radium in the world is about 320 grams, of which America possesses more than half.

Physical Properties.—The action of radium depends on its physical properties, and these must be referred to briefly. The modern view of the atom is that it is composed of a nucleus carrying a positive charge around which the outer electrons are distributed; these electrons are in a state of constant motion and each carries a negative charge. In a neutral atom the electrons must carry a total charge equal to the charge of the nucleus. The nuclear charge of hydrogen is 1, of helium 2, up to radium with a charge of 88, and uranium with a charge of 92.

The radium atom is remarkable because it breaks up by expelling a single alpha particle, which represents the nucleus of the helium atom, with a charge of 2, or by shooting off an electron (beta particle). The expulsion of the alpha particle lowers the nuclear charge of the atom of radium by two units, and a substance referred to as "emanation" is produced, which is composed of a gas, niton, allied to argon. Further expulsion of alpha and beta particles produces a series of radio-active elements known as radium A, B, C, D, E, and F, until ultimately lead is formed, which is non-radio-active. No protons (hydrogen nuclei) are emitted, but only helium nuclei and electrons. Radium salts are thus being continually transformed into other metals, and it has been estimated that about half the radium will be transformed in 1,700 years. The activity of radium salts is measured by the discharge of a gold-leaf electroscope. Radium emanation, or radon, collected in capillary tubes, has the same effect as radium, but its activity is soon lost, ceasing within a few days.

Radium, then, has three known types of radiation: alpha particles of helium, which are readily stopped by paper or the skin; beta

particles or electrons, which are stopped by 2 or 3 mm. of aluminium, and gamma rays, a type of X-ray, but four times harder than anything which can be produced by bulbs. The gamma rays are produced by the energy liberated in the expulsion of the alpha and beta particles. Substances like lead-foil, or even common salt, placed in the neighborhood of radium become coated and can be similarly used for superficial applications. The only radio-active substance present in the body is potassium, and the gamma rays which it emits are of greater penetrating power than those emitted by radium.

Local Action.—In surgery, to destroy tissues. For general purposes emanation is to be preferred to the metal (convenience, economy, and safety). The parts of the body most susceptible to radium are the lymphatic system, including the spleen, the gonads, and, though to a smaller extent, the central nervous system. One explanation of the selective action on tissues is the fact that radium decomposes lecithin, and it is the tissues richest in lecithin which are most affected. It has also been suggested with good evidence that the degenerative changes seen after radium are due to the toxic action of this decomposed lecithin. It may also be accepted on broad lines that the susceptibility of tissues to radium varies with their rate of growth.

One other point is worth noting: the gamma rays increase the activity of the autolytic ferments, thus facilitating the absorption of dead cells.

Systemic Action.—Radium is sometimes administered internally to produce system effects. Salts of radium taken by mouth are rapidly absorbed, penetrate the whole body, and are excreted as emanation and radium by the lungs, and, to a smaller extent, in the urine. The best method of administration for general effect, however, is to use water charged with emanation. A usual amount is half a pint daily containing 1.5 to 2 millicuries per liter. The most successful use to which it has been put is to relieve pain in fibrous arthritis, sciatica, and tabes (a kind of shock treatment somewhat analogous to protein-shock therapy).

Radium also increases the coagulability of the blood to a considerable degree. In the leukemias the local application of radium over the lymphatic glands and spleen has caused temporary improvement. It is well known that both X-rays and radium diminish the leukocytes and the size of the spleen in leukemia, though no permanent improvement in the disease occurs with either.

Radium has been used also in many other diseases, such as gout, glycosuria, arteriosclerosis, and high blood pressure, but the beneficial results sometimes accredited to the treatment are altogether unconvincing.

H. W. Dundas Mackenzie, M.D.

ENCEPHALOGRAPHY

Encephalography: Roentgenological and Clinical Considerations for Its Use. Henry K. Pancoast and Temple Fay. Am. Jour. Roentgenol. and Rad. Ther., May, 1929, XXI, 421.

Air injections of the cerebrospinal fluid pathways, either by the introduction of air into the lumbar space or by direct introduction into the cerebral ventricles, after previously withdrawing cerebrospinal fluid, have been performed for diagnostic purposes since as early as 1918 or 1919, but only more recently have large series of cases been reported, to show that the procedures can be carried out with a mortality of less than 2 per cent by properly selecting the procedure which will be most diagnostic and for which there are no definite contra-indications. Encephalography is indicated in anterior and middle fossa lesions (supratentorial and cortical conditions), while ventriculography is more desirable and safer in posterior fossa lesions.

The writers' technic consists in first determining the spinal fluid pressure, which, when over 20 mm. Hg. in the prone position, is considered as a contra-indication to the examination, unless it can be ascertained that the cortical fluid pressure, ventricular pressure, and spinal fluid pressure are equal. If the case

satisfies these requirements, two unbreakable spinal puncture needles are then introduced in the third and fourth lumbar interspaces, the upper needle being connected to a mercury manometer for determining the pressure at the beginning and at the end of the procedure. With the spinal fluid withdrawn from the lower needle until the pressure exerted at the manometer is reduced to about 8 mm. Hg, the patient is carefully raised to the sitting posture and further fluid is withdrawn through the lower needle until the pressure has again been reduced to from 8 to 10 mm. Hg. At this point air is injected from a sterile syringe until the pressure has been brought back to 20 mm. Hg. Further spinal fluid is allowed to drain, to again reduce the pressure, after which air is again injected, and this procedure is repeated until from 90 to 120 c.c. of fluid has escaped and been replaced by from 80 to 100 c.c. of air. During this procedure the patient's head is rotated and flexed and extended upon the chest in order to entirely empty the ventricles. After removing the last fraction of fluid and injection of air, the pressure is allowed to fall to 10 mm. Hg, with the patient in the sitting position. After removal of both needles stereoscopic films are made in either the antero-posterior or postero-anterior position and also in the lateral position, the patient's head and trunk being constantly maintained in the vertical position. Severe headache, faintness, and profuse sweating usually follow the procedure, but may be controlled in part by large doses of chloral hydrate or codeine given prior to the examination. All films are made with a vertical flat Bucky diaphragm in order to get the maximum of contrast in the shadows.

Approximately 80 per cent of idiopathic epilepsy cases have shown grossly abnormal encephalograms. A few cases of post-traumatic headache have been definitely benefited by the procedure. In a large percentage of cases the encephalograms assist in determining the operability or inoperability of a given case and they also aid in determining the site of operation.

Encephalography and ventriculography are often complementary procedures.

J. E. Habbe, M.D.

BLOOD CHANGES

Clinical Results with Intense Red Radiation, with Studies of the Blood Count. H. Cramer and G. Fechner. Strahlentherapie, 1929, XXXIII, 186.

It is an accepted fact that small doses of roentgen rays are often beneficial in acute inflammatory diseases. There are, however, a number of chronic processes as, for instance, neuralgia, parametritis, and arthritis, which do not respond well to that treatment. The author studied the effect of infra-red rays (6,000 to 8,000 Å.) in these diseases. The applicator could be inserted into body cavities (mouth, vagina, rectum). A careful study of the blood count in treated cases revealed the fact that a favorable reaction was usually accompanied by an increase in the lymphocytes. However, improvement has been observed in cases where this lymphocyte rise was missing.

E. A. Pohle, M.D., Ph.D.

The Changes of Blood Cholesterol *in vitro*. A. H. Roffo and H. Degiorgi. Strahlentherapie, 1929, XXXIII, 385.

Roffo reported, in 1925, that roentgen rays destroy cholesterol dissolved in chloroform. If a 0.02 per cent solution is used, an exposure of eighteen minutes (200 K.V., 4 ma., 17 cm. distance, no filter) leaves only a trace of cholesterol in the test tube. The irradiation of human serum *in vitro* led to the same results; in some cases, the destruction was as high as 67 per cent. Its degree depended upon the time of exposure and the quantity of cholesterol present in the serum before irradiation. The effect of irradiation was most pronounced in the sera with low cholesterol content. The surface tension of the serum hardly changed.

E. A. Pohle, M.D.

SURGERY

The Debt of Modern Surgery to the Ancillary Sciences. Arthur H. Burgess. Can. Med. Assn. Jour., September, 1929, XXI, 257.

The debt of modern surgery to the ancillary sciences is the subject of the presidential address to the British Medical Association at Manchester, July 23, 1929.

The great achievements in surgery have not been—nor could they have been—achieved without the material assistance of the contemporary advances in the allied sciences. Physics and physiology are the two sciences to which surgery, in recent times, is most indebted. In the department of physics the greatest contributions have been made from X-ray, radium, and light therapy. The extent of the accomplishments of the X-ray in the diagnostic field is concisely covered. Strangely enough, the therapeutic value of the X-ray is not even mentioned.

L. J. CARTER, M.D.

ULTRA-VIOLET LIGHT

Properties and Use of the Ultra-violet Bulb (Osram-Vitaluxlampe). A. Rüttenauer. Strahlentherapie, 1929, XXXII, 597.

This ultra-violet lamp is an electric bulb with a glass which transmits ultra-violet radiation. It is built for 300 watts and 500 watts and is supposed to last 300 hours. The spectral intensity distribution curve is similar to that of the sun, with a maximum around 9,000 Å.; it reaches as far as 2,800 Å. in the ultra-violet region. Its therapeutic use should be indicated whenever natural sunlight is not available.

E. A. POHLE, M.D., PH.D.

Quantitative Measurements in the Visible and Ultra-violet Spectrum of the Blood and its Components. III.—Comparative Measurements on Blood Corpuscles and Plasma of Various Animals. R. Suhrmann and Werner Kollath. Strahlentherapie, 1928, XXX, 145.

The absorption of plasma, serum, and red blood corpuscles of a number of animals (rat, guinea pig, pigeon) in the visible and ultra-violet regions was studied. The absolute curves for serum of rats and pigeons show a great difference, undoubtedly due to a different composition. Good agreement is observed between the curves of the erythrocytes of rats, guinea pigs, and man.

E. A. POHLE, M.D., PH.D.

On the Use of a Physical Unit (Hefner Candle) as Standard in the Measurement of Ultra-violet Light. E. Björling. Strahlentherapie, 1928, XXX, 157.

This is a description of a photographic method linked up with a modified Hefner candle, which is recommended for the calibration of mercury vapor lamps.

E. A. POHLE, M.D., PH.D.

BONE TUMORS

A Roentgenologic Consideration of Endothelial Myeloma. B. R. Kirklin and Harry M. Weber. Am. Jour. Roentgenol. and Rad. Ther., April, 1929, XXI, 355.

Of the total number of cases in the Registry of Bone Sarcoma, 67 (or approximately 10 per cent) were classed as endothelial myelomas, which percentage is in close agreement with Kirklin's series of 9 such tumors in a series of 78 consecutively operated upon malignant bone tumors. All 9 cases had biopsy diagnostic confirmation and all received radiotherapy. Two patients died within a year after the onset of symptoms and one within two years. All three showed terminal metastases. The age limits were 2½ and 29 years. Four cases involved the femur, two the fibula, one each the humerus and tibia, and one the scapula. The greatest difficulty encountered in the diagnosis was in differentiating the condi-

tion from chronic osteomyelitis. However, the more even destruction, the less marked reparative reaction, and the earlier periosteal destruction all argue in favor of Ewing's tumor. After radiation therapy the development of a delicate, lacy, veil-like shadow about the involved area of bone is a fairly constant and characteristic therapeutic sign.

J. E. HABBE, M.D.

THYROID

Present Status of Thyroid Surgery. A. B. Cooke. Calif. and West. Med., April, 1929, XXX, 263.

In discussing this subject in the section on "Bedside Medicine for Bedside Doctors," Dr. Cooke speaks of the startling statistics which show a general increase in surgical mortality rates during recent years, thyroid surgery heading the list with a mortality rate which has increased 250 per cent in the past two decades. However, prior to this time thyroid work was done almost exclusively by a few experts, while to-day it is being done by almost every local surgeon. He states that, while no one denies benefit may be expected from radiation therapy in properly selected cases, he believes, however, that surgery is the method of treatment *par excellence.*

FRANCIS B. SHELDON, M.D.

THYMUS

The Roentgen Diagnosis and Treatment of Enlarged Symptomless Thymus. Frederick W. O'Brien. Am. Jour. Roentgenol. and Rad. Ther., March, 1929, XXI, 271.

The author attempts to settle two points with regard to the "thymus question." The first problem, with regard to the roentgen treatment of infants presenting an enlarged thymus shadow and symptoms, he answers with an unequivocal statement that all such cases should have X-ray treatment, which will produce a quick and harmless involution of the gland. The second point deals with infants showing an enlarged thymus shadow without any symptoms referable to it, and in such cases our present-day knowledge of the thymus, its development and functions, should lead us to the belief that such cases should have irradiation only if a general anesthesia and surgery are contemplated, since many in this group present glands in no sense pathologic.

J. E. HABBE, M.D.

URINARY TRACT

Visualization of a Cystocele by Cystogram. H. Gurth Pretty. Can. Med. Assn. Jour., November, 1929, XXI, 558.

A slight hernia of the bladder through pubovesico cervical fascia immediately below the trigone, so slight as not to be recognized as a cystocele, sets up a trigonitis, which will give rise to the typical triad of frequency, urgency, and dysuria. This condition may not be recognizable by the ordinary means of examination used by the urologist or the gynecologist. By means of a cystogram, after the injection of 200 to 300 c.c. of silver nitrate, the degree of herniation of the bladder may be accurately determined. Similarly cystograms taken of a cystocele before and after operation will reveal the degree of herniation and the improvement, or otherwise, resulting from the operation. After the injection of the silver iodide solution into the bladder, with the patient in a reclining position, the cystogram is taken in the erect position, using a Bucky diaphragm. The normal line for the base of the bladder in such a cystogram is a line drawn at right-angles to the vertical plane of the symphysis pubis, at the junction of the upper and middle third. The amount of the sagging of the shadow below this line indicates the extent of the cystocele.

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